IN THE UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF TEXAS
AUSTIN DIVISION

AMERICAN STEWARDS OF LIBERTY, *et al.*, Plaintiffs, JOHN YEARWOOD and WILLIAMSON COUNTY, TEXAS, Plaintiff-Intervenors, v. DEPARTMENT OF INTERIOR, *et al.*, Defendants, CENTER FOR BIOLOGICAL DIVERSITY, DEFENDERS OF WILDLIFE, and TRAVIS AUDUBON, Defendant-Intervenors.	Civil No. 1:15-cv-01174-LY **DEFENDANT-INTERVENORS' EXCERPTS OF ADMINISTRATIVE RECORD – VOLUME ONE**

VOLUME ONE

BATES NUMBERS	NAME OF DOCUMENT
M003393 - M003424	90-Day Finding on a Petition to Remove the Bone Cave Harvestman From the List of Endangered and Threatened Wildlife
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R000315 - R000337	Bone Cave Harvestman (*Texella reyesi*) 5-Year Review: Summary and Evaluation
R001734 - R001830	Examining possible foraging differences in urban and rural cave cricket populations: Carbon and nitrogen isotope ratios ($\delta^{13}C$, $\delta^{15}N$) as indicators of trophic level
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Administrative Record Excerpt 1

M003393 - M003424

90-Day Finding on a Petition to Remove the Bone Cave Harvestman from the List of Endangered and Threatened Wildlife

Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition To Remove the Bone Cave Harvestman From the List of Endangered and Threatened Wildlife

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 90-day petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), announce a 90-day finding on a petition to remove the Bone Cave harvestman (*Texella reyesi*) from the List of Endangered and Threatened Wildlife under the Endangered Species Act of 1973, as amended (Act). Based on our review, we find that the petition does not present substantial scientific or commercial information indicating that the petitioned action may be warranted. Therefore, we are not initiating a status review in response to this petition. However, we are in the process of conducting a species status assessment and 5-year status review and we invite the public, including the petitioners and other interested parties, to submit new data and information for consideration in this ongoing process. In particular, we ask the public to submit to us any new information that becomes available concerning the status of, or threats to, the Bone Cave harvestman or its habitat at any time.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(A) of the Act (16 U.S.C. 1531 et seq.) requires that we make a finding on whether a petition to add a species to ("list"), remove a species from ("delist"), or reclassify a species on the Lists of Endangered and Threatened Wildlife and Plants presents substantial scientific or commercial information indicating that the petitioned

action may be warranted. We are to base this finding on information provided in the petition, supporting information submitted with the petition, and information otherwise available in our files. To the maximum extent practicable, we are to make this finding within 90 days of our receipt of the petition and publish our notice of the finding promptly in the **Federal Register**.

The Services revised the regulations at 50 CFR 424.14 to clarify the procedures under which the Services evaluate petitions effective October 27, 2016 (81 FR 66462; September 27, 2016). We originally received the petition that is the subject of this document on June 2, 2014, with supplemental information received on October 5, 2016. We therefore evaluated this petition under the 50 CFR 424.14 requirements that were in effect prior to October 27, 2016, as those requirements applied when the petition and supplemental information were received.

Our standard for substantial scientific or commercial information with regard to a 90-day petition finding was "that amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted" (50 CFR 424.14(b)(1)). If we find that substantial scientific or commercial information was presented, we are required to promptly conduct a species status review, which we subsequently summarize in a 12-month finding.

Petition History

On June 2, 2014, we received a petition from John Yearwood, Kathryn Heidemann, Charles and Cheryl Shell, the Walter Sidney Shell Management Trust, the American Stewards of Liberty, and Steven W. Carothers requesting that we remove the endangered Bone Cave harvestman from the Federal List of Endangered and Threatened

Wildlife. The petition clearly identified itself as a petition and included the requisite identification information for the petitioners, as required at 50 CFR 424.14(a) (now 50 CFR 424.14(c)(1)). On June 1, 2015, the Service published a 90-day finding in the **Federal Register** (80 FR 30990) that the petition did not present substantial scientific or commercial information indicating that the petitioned action was warranted. On December 15, 2015, the American Stewards of Liberty, Charles and Cheryl Shell, Walter Sidney Shell Management Trust, Kathryn Heidemann, and Robert V. Harrison, Sr. challenged the 2015 90-day finding in Federal district court. The Service sought the court's permission to reconsider the 90-day finding. On December 22, 2016, the court ordered the Service to complete a new 90-day finding and deliver that finding to the **Federal Register** on or before March 31, 2017. This 90-day finding supersedes the Service's previous 2015 90-day finding, and is made pursuant to the court's December 22, 2016 order, the 2014 petition, and the additional reference materials accompanying the petition.

Previous Federal Actions

On September 16, 1988, the Service determined that the Bone Cave harvestman was endangered under the ESA (53 FR 36029). The 1988 final listing determination included five separate species, one of which was the Bee Creek Cave harvestman. Subsequent scientific studies concluded that the Bee Creek Cave harvestman actually consisted of two separate species: the Bee Creek Cave harvestman and the Bone Cave harvestman. As a result, the Service made a technical correction to include both species on the list of endangered species (58 FR 43818; August 18, 1993).On March 14, 1994, we published a 90-day finding (59 FR 11755) on a petition to delist the Bone Cave

harvestman in which we found that the petition did not present substantial scientific or commercial information indicating that the petitioned action may have been warranted. We developed a draft recovery plan on June 7, 1993, and made it final on August 25, 1994 (Service 1994b). On December 4, 2009, we completed a 5-year review of the Bone Cave harvestman, which recommended that the species remain listed as endangered (Service 2009). On June 1, 2015, we published a 90-day finding (80 FR 30990) on a petition to delist the Bone Cave harvestman which was subsequently withdrawn. This 90-day finding supersedes the Service's 2015 90-day finding. We announced our initiation of a 5-year review of the Bone Cave harvestman, and requested information for that review, on April 15, 2015 (80 FR 20241).

Species Information

For information on the biology and life history of the Bone Cave harvestman, see the final rule listing this species (53 FR 36029; September 16, 1988), the Endangered Karst Invertebrates Recovery Plan for Travis and Williamson Counties (Service 1994b), and the 5-year Status Review for the Bone Cave Harvestman (Service 2009), all posted at *http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=J009*. For information on preserve design and management for karst invertebrate species conservation, see the Karst Preserve Design Recommendations (Service 2012) and the Karst Preserve Management and Monitoring Recommendations (Service 2014) posted at *http://www.fws.gov/southwest/es/AustinTexas/ESA_Sp_KarstInverts.html*.

Evaluation of Information for This Finding

Under section 3(16) of the Act, we may consider for listing any species, including subspecies, of fish, or wildlife, or plants, and any distinct population segment of any

species of vertebrate fish or wildlife that interbreeds when mature (16 U.S.C. 1532(16)). Such entities are listed under the Act if we determine that they meet the definition of an endangered or threatened species.

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations at 50 CFR 424 set forth the procedures for adding a species to, or removing a species from, the lists of endangered and threatened species. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1) of the Act: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade factors affecting its continued existence.

We must consider these same five factors in delisting a species. We may delist a species according to 50 CFR 424.11(d) if the best available scientific and commercial data indicate that the species is neither endangered nor threatened for the following reasons: (1) The species is extinct; (2) The species is recovered; or (3) The original data for classification were in error. According to 50 CFR 424.11(d)(3), a species may be delisted when subsequent investigations "show that the best scientific and commercial data available when the species was listed, or the interpretation of such data, were in error."

In making this 90-day finding, we evaluated whether the petition presented substantial information indicating that the petitioned action (delisting) may be warranted. The petition did not assert that the Bone Cave harvestman is extinct, nor do we have

information in our files indicating that the species is extinct. The petition asserted that new information indicates that the original data, or our interpretation of the data, used in the listing of this species were in error. The petition also states that significant conservation has been put in place since the species was listed, such that the species is recovered.

In 2009, we conducted a 5-year status review of the Bone Cave harvestman (Service 2009). The purpose of a 5-year status review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on a 5-year review, we recommend whether a species should be removed from the List of Endangered and Threatened Wildlife, be changed in status from endangered to threatened, be changed in status from threatened to endangered, or remain at its current status. As part of the 2009 Bone Cave harvestman review, we evaluated whether the species had met the recovery criteria laid out in the species' recovery plan (Service 1994b, pp. 86–89).

Our Recovery Planning Guidance (NMFS and Service 2010) points out that recovery criteria should address the biodiversity principles of resiliency, redundancy, and representation (Schaffer and Stein 2000). Resiliency is the ability of a population or species to persist through severe hardships or stochastic events.

Redundancy refers to ensuring a sufficient number of populations to provide a margin of safety to reduce the risk of losing a species or certain representation (variation) within a species due to catastrophic events or other threats.
Representation involves conserving "some of everything" with regard to genetic and ecological diversity to allow for future adaptation and maintenance of evolutionary

potential. Representation and the adaptive capabilities (NMFS and Service 2010, p. 76994) of the Bone Cave harvestman are also important for long-term viability. Because a species' genetic makeup is shaped through natural selection by the environments it has experienced (Shaffer and Stein 2000, p. 308), populations should be protected in the array of different environments in which the invertebrate species occur as a strategy to ensure genetic representation, adaptive capability, and conservation of the species. Generally, the more representation, or diversity, the species has, the more it is capable of adapting to changes (natural or human-caused) in its environment.

The recovery plan for the Bone Cave harvestman (Service 1994b, pp. 86–88) identifies criteria for reclassification (from endangered to threatened), but does not include delisting criteria because we were unable to determine criteria for delisting the species at that time. Although meeting recovery criteria is not the standard for delisting, these reclassification recovery criteria are discussed here as a way of measuring our progress toward recovery and assessing the current status of the species. The recovery plan identifies two criteria for reclassifying the species from endangered to threatened: (1) Three karst fauna areas (if at least three exist) within each karst fauna region in its range are protected in perpetuity. If fewer than three karst fauna areas exist within a given karst fauna region, then all karst fauna areas within that region should be protected. (2) Criterion (1) has been maintained for at least 5 consecutive years with assurances that these areas will remain protected in perpetuity.

Karst fauna regions are geographic regions delineated based on geologic continuity, hydrology, and species distribution (Service 1994b, p. 76). There are six karst fauna regions in Travis and Williamson Counties, Texas, that are known to contain the

Bone Cave harvestman (Service 1994b, p. 33): North Williamson, Georgetown, McNeil/Round Rock, Cedar Park, Jollyville Plateau, and Central Austin. These regions are used as a way to facilitate conservation of representation and redundancy (as defined above) throughout the species' range.

Karst geologic areas were initially established for Travis and Williamson Counties, Texas, in 1992 (Veni & Associates 1992) and subsequently incorporated as karst fauna regions into the Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas (Service 1994b, pp. 28-34). Karst species zones, geographic areas used to denote the potential for listed karst invertebrate occurrence, were revised in 2007 for Travis and Williamson Counties, Texas (Veni and Martinez 2007). That revision incorporated additional species occurrence data and more robust geological mapping, and provided a more refined assessment of species distribution. While some studies suggest specific karst fauna regions could be redefined (Paquin and Hedin 2004, p. 3250; White 2006, pp. 93-99), they remain an overall suitable conservation strategy to aid in species recovery (Veni and Martinez 2007, p. 25; Ledford *et al.* 2012, p. 12).

For the purposes of the recovery plan, a karst fauna area "is an area known to support one or more locations of a listed species and is distinct in that it acts as a system that is separated from other karst fauna areas by geologic and hydrologic features and/or processes that create barriers to the movement of water, contaminants, and troglobitic fauna" that live their entire lives underground (Service 1994b, p. 76). Karst fauna areas should be far enough apart so that if a catastrophic event (for example, contamination of the water supply, flooding, disease) were to destroy one of the areas, that event would not

likely destroy any other area occupied by that species (Service 1994b, p. 76).

To be considered "protected," a karst fauna area must be sufficiently large to maintain the integrity of the karst ecosystem on which the species depends (Service 1994b, p. 87). In addition, these areas must also provide protection from threats such as red imported fire ants, habitat destruction, and contaminants.

The overall recovery strategy for the Bone Cave harvestman includes the perpetual protection and management of an adequate quantity and quality of habitat (three karst fauna areas in each karst fauna regions) that spans the species' geographic range and provides a high probability of the species' recovery and survival over the long term. Adequate quality (as discussed below) and quantity of habitat refers to both size and number of preserved karst fauna areas that are sufficient for supporting the karst invertebrates and the ecosystems upon which they depend (Service 2011, p. 16). The recovery plan criteria call for three karst fauna areas (preserves) in each karst fauna region. The size of karst fauna area preserves should be large enough to ensure resiliency, as discussed above, and to protect the environmental integrity of the karst ecosystems upon which the species depends. The number of karst fauna area preserves called for in the recovery criteria provides redundancy for the species. A minimal level of redundancy within areas representing differing ecological and genetic makeup is essential to provide a margin of safety for the species to reduce the risk of losing the species or representation (variation) within the species from catastrophic events or other threats (Shaffer and Stein 2000 pp. 307, 309–310; Groves *et al.* 2002, p. 506). The Bone Cave harvestman has significant geographic variability across its range, and loss of a significant number of locations in part of its range could result in loss of genetic and

ecological diversity. The conservation of multiple karst fauna area preserves across the Bone Cave harvestman's range should provide representation of the breadth of its genetic and ecological diversity to conserve its adaptive capabilities (Schaffer and Stein 2000, p. 308).

Adequate quality of habitat refers to (1) the condition and configuration of preserved lands with respect to the known localities for the species, and (2) the ability of the species' needs to be met to sustain viable populations. Due to the uncertainty in determining population viability of the Bone Cave harvestman, the design of preserves for its protection should be based on estimates and assumptions that favor a high probability for recovery of this species and the ecosystems upon which it depends as discussed below.

The Endangered Karst Invertebrates Recovery Plan for Travis and Williamson Counties (Service 1994b) calls for protecting karst fauna areas sufficiently large to maintain the integrity of the karst ecosystem on which the species depends. This focus on the ecosystem is consistent with the purposes of the Act, which include "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved" (16 U.S.C. 1531(b)). Therefore, we recommend designing karst fauna area preserves to protect occupied karst feature(s) and associated mesocaverns (humanly impassable voids). For further guidance on how to provide for adequate quantity and quality of habitat at specific invertebrate locations, we have developed and refer to our Karst Preserve Design Recommendations (Service 2012).

According to our preserve design guidelines (Service 2012, p. 3-5), karst fauna area preserves should include the following: (1) Surface and subsurface drainage basins

of at least one occupied cave or karst feature; (2) a minimum of 16 to 40 hectares (ha) (40 to 100 acres (ac)) of contiguous, unfragmented, undisturbed land to maintain native plant and animal communities around the feature and protect the subsurface karst community; (3) 105-meter (m) (345-feet (ft)) radius of undisturbed area from each cave footprint for cave cricket foraging (cave crickets are an important source of nutrient input to the karst ecosystem) and to minimize deleterious edge effects; and (4) preserves free of pipelines, storage tanks, or other facilities (for example, water retention ponds) that could cause contamination.

Because of the difficulties determining the population viability and habitat requirements for Bone Cave harvestman, this method follows a precautionary approach, which provides guidance to avert irreversible risk when facing uncertainty (Service 2012, p. A-1). Life-history characteristics of this species indicate that it requires stable temperature and humidity (Barr 1968, p. 47; Mitchell 1971, p. 250), and suggest that this species cannot be reintroduced because it cannot withstand surface climatic conditions.

According to anecdotal reports provided to our Austin Ecological Services Field Office, limited efforts to maintain karst invertebrates in a lab setting have been unsuccessful. Additionally, captive propagation techniques have not been developed for karst invertebrates and may be challenging to develop because of their specific adaptations to subterranean environment. Further, the sample size that would likely be needed to reintroduce a population into a new location cannot be obtained from existing populations due to the cryptic nature of this species and the fact that often only a few individuals are observed per cave survey. Therefore, an attempt to re-establish a population after it has been extirpated is not feasible at this time. In addition, if a

preserve is later found to be insufficient to support the species due to surrounding developments being either too close or too dense, the potential for adequately conserving the site is lost.

Because the Bone Cave harvestman has a relatively long life span and low requirements for food, a decline in population size or even the complete extirpation of the population due to the influence of development or other threats may take years or even decades. Observations of this species over several years on a preserve that is too small for perpetual species preservation may not allow detection of declines that are actually occurring. If these observations are used as evidence that a preserve size was adequate, then the potential for long-term preservation of the species may be lost due to irreversible development surrounding the preserve. Therefore, preserve sizes should be established with caution and be large enough to account for the uncertainty in area requirements for a population.

According to the petition, there are now more known occupied locations identified; there were 6 confirmed caves at listing; 60 confirmed caves at the time the recovery plan was drafted; and 168 confirmed caves in 2009, when the 5-year status review was completed (53 FR 36029, September 16, 1988; Service 1994b, 2009). The petition also states that more locations are likely to be found. We acknowledge that there are more known locations since the time those documents were completed and that the increase is likely an increase in our knowledge, not a true increase in the number of populations or range; however, species are listed under the Act based on an overall assessment of their viability and threats to their continued existence and not a simple assessment of the number of sites or size of the species' range. Some of the ongoing

threats to the species include habitat loss to development, alteration of drainage patterns, alteration of surface plant and animal communities, and contamination.

The petition states that 94 karst preserve areas are currently providing significant conservation. While these karst preserve areas are an important tool for preserving the current population of Bone Cave harvestman, many of the existing protected areas referenced in the petition are too small to meet the Service's preserve design recommendations. As part of the 2009 5-year status review of the Bone Cave harvestman, we reviewed the status of all of the known locations of the harvestman (including 83 of the 94 mentioned in the petition) to assess whether the criteria from the recovery plan to reclassify the species from endangered to threatened had been met for the Bone Cave harvestman. We considered the habitat size and condition to evaluate whether the locations could meet the preserve design recommendations (a reflection of the potential to support a resilient population) and then also looked at whether legally binding mechanisms were in place to provide protection of these sites over the long term (in perpetuity).

Of the locations known at the time of the 5-year review, 21 areas appeared to have the potential to meet the preserve design criteria. Our status review refers to 21 areas, while the petition incorrectly indicates that the status review considered 28 sites. This discrepancy is because the petition considers each individual cave location, while our status review considered closely located caves to be part of the same karst fauna area. Of these 21 areas, 1 is no longer confirmed to have the species (Barker Ranch Cave No. 1), and 5 are now protected karst fauna areas (Priscilla's Well, Twin Springs, Cobbs Cavern, Karankawa, and Tooth Cave).

In addition, at most of the remaining locations (of the 21 areas), we lack information to confirm that they meet the preserve design criteria (such as whether the surface and subsurface drainage basins are protected; tract acreage; exact locations of the cave within the area; and management activities to protect against threats, such as red imported fire ants). Also, many of these areas do not have a legally binding mechanism that ensures perpetual protection and management. Hence, we are unsure whether those areas have adequate undeveloped acreage, management, or protection mechanisms to ensure the long-term protection and survival of the Bone Cave harvestman.

Of the five protected karst fauna areas that meet preserve design criteria, four occur in the North Williamson County Karst Fauna Region and one occurs in the Jollyville Plateau Karst Fauna Region. However, this species occurs in six karst fauna regions, and four of these have no protected karst fauna areas that are confirmed to meet preserve design recommendations. Therefore, the best available information indicates that the criteria for reclassification from endangered to threatened for this species have not been met, nor has adequate redundancy and representation (three karst fauna areas in each karst fauna region) been protected throughout the species' range, leaving the species vulnerable to existing threats including habitat destruction.

The petition asserts that four additional locations are known since the time of the 5-year review. However, the petition does not provide adequate information that would support whether these four additional locations are in a condition to meet preserve design recommendations. Based on information in our files, we are aware of one additional cave since the 5-year review that may meet preserve design recommendations in the North Williamson Karst Fauna Region; however, it is privately owned, and we are unsure about

the property acreage and if the site receives any type of protection or management. Regardless, the amount of protected karst fauna area still falls short of the criteria for reclassification from endangered to threatened.

Further, we reviewed 83 of the 94 caves identified in the petition as receiving some level of protection in the 5-year review. Two of the caves that we did not review (Cobbs Cavern and Whitney West Cave) are now in confirmed karst fauna areas mentioned above (Cobbs Cavern and Twin Springs); one (Pond Party Pit) is in the Beard Ranch Cave area discussed in the 5-year review; and we have no locality information or taxonomic verifications for the remaining caves, and this information was not provided in the petition.

The petition also asserts that threats to the species are not as severe as originally thought. We evaluate that information, below, with respect to the five listing factors.

Factor A: The present or threatened destruction, modification, or curtailment of the species' habitat or range. In the 1988 listing rule (53 FR 36029), we stated that the primary threat to the Bone Cave harvestman was the potential loss of habitat due to development activities, which could result in filling in or collapsing of caves; alteration of drainage patterns; increase in flow of sediment, pesticides, fertilizers, and urban run-off into caves; and increase in human visitation and vandalism.

We also considered additional information on threats to the species when we developed the recovery plan for the species (Service 1994b, pp. 59–65) and when we conducted the 5-year status review of the species (Service 2009, p. 2), in which we concluded that no change in the species' status (that is, reclassification to threatened or delisting) was warranted. We also reviewed available threat information in our files and

in a 1993 petition when we made our negative 90-day finding on that petition to delist (59 FR 11755; March 14, 1994).

The current petition asserts that "[d]evelopment activities on the surface may not result in the significant loss or degradation of habitat for *T. reyesi* as originally thought" and suggests that evidence of this is persistence of the species in caves surrounded by developed areas. Examples given in the petition are Inner Space Caverns, Sun City caves, Weldon Cave, Three-Mile Cave, and Four-Mile Cave. However, the observation of the species in these locations does not mean their populations at these locations are thriving or can withstand the long-term impacts from development activities that are expected to occur to karst invertebrate populations in developed areas, as discussed in the listing rule, recovery plan, and 5-year status review for the Bone Cave harvestman. In addition, increased development provides greater opportunities for contamination events such as pipeline leaks or hazardous material spills.

Bone Cave harvestman populations may be declining or threatened even though they are still observed at a specific site. The petition does not provide adequate information to detect population trends for this species and it is not available from other sources. This species has life-history strategies that include characteristics such as low metabolic and reproductive rates, long life spans, and inherently low sample sizes, which make it difficult to detect population response to possible impacts (Poulson and White 1969, p. 977; Howarth 1983, p. 374). We indicated in the 1994 90-day petition finding (59 FR 11755) that more time was needed to detect if the species was declining; however, while more time has passed, we are still lacking adequate data to conduct a trend analysis. It may be infeasible to assess karst invertebrate population trends in any

statistically significant manner given their association with humanly inaccessible cave habitat such as mesocaverns (Krejca and Weckerly 2007, p. 287). Human surveyors likely only have the opportunity to survey individuals from a subset of the available habitat (Knapp and Fong 1999, p. 6).

The petition states that several Sun City caves are examples of areas where the species can persist in developed areas. However, the petition failed to provide data adequate to assess trends in the karst invertebrate populations since the development occurred. In addition, we worked with the Sun City developers when they designed the project to develop strategies that we believed at the time would avoid or minimize the possibility of "take" of listed karst species. While we now believe that most of the Sun City cave preserves are too small to meet our preserve design recommendations for recovery and long-term survival (Service 2012), we expect that the strategies and conservation measures put in place likely have reduced the rate of impacts to the species.

The commercial cave known as Inner Space Caverns is another example the petition provided where the Bone Cave harvestman continues to persist in a developed area. Although the Bone Cave harvestman may be present at Inner Space Caverns, this does not ensure its populations are robust and secure; they may still be declining, and are at risk due to competition with surface-dwelling invertebrates and other threats associated with development, such as the potential for contamination. This cave has an overgrowth of blue-green algae growing near cave lights where the petition states that this species has been observed. This type of algae is known as "lampenflora" and favors surface-dwelling invertebrate species that can out-compete karst invertebrate species (Mulec and Kosi 2009, p. 109; Culver 1986, p. 438), such as the Bone Cave harvestman. The petition

failed to provide any data adequate to assess trends in the karst invertebrate population in relation to the time (duration and frequency) that they have been exposed to the artificial lighting. Additionally, part of the cave footprint occurs under a major interstate highway and train tracks, both of which present a threat of a contaminant spill that could impact the species in the future.

Weldon Cave was another example in the petition of a cave occupied by the Bone Cave harvestman within a developed area. Based on the best available information in our files, this cave is surrounded by undeveloped open space. Other than a small portion of the subsurface drainage basin potentially being impacted by a school campus, this cave appears to meet our preserve design recommendations but is not within a developed area, as asserted in the petition. Three-Mile Cave and Four-Mile Cave were also provided in the petition as examples of developed caves wherein the Bone Cave harvestman is known to occur. According to the petition, surveys conducted by SWCA in 2008 and 2009 documented the Bone Cave harvestman at these locations. However, detailed survey data were not provided by the petitioners and were not in the SWCA 2009 "Annual Report of Activities Involving Endangered Karst Invertebrates under Threatened and Endangered Species Permit TE800611–2."

The petition also states that, since the Bone Cave harvestman uses mesocaverns, it is protected from surface development activities because mesocaverns are "geologically protected." We are unclear why the petition contends that mesocaverns are protected because mesocaverns are subject to rapid permeation of surface water (Cowan *et al.* 2007, p. 160), and karst landscapes (including mesocaverns) are particularly susceptible to groundwater contamination because water penetrates rapidly through bedrock conduits

providing little or no filtration (White 1988, p. 149).

One of the major threats to the Bone Cave harvestman is habitat loss due to increasing urbanization. The Bone Cave harvestman is a troglobite, meaning it lives its entire life underground. Karst ecosystems are heavily reliant on surface plant and animal communities for nutrient input.

Caves in central Texas that are occupied by federally listed karst invertebrates, such as the Bone Cave harvestman, receive energy (or nutrients) primarily from (1) detritus (decomposing organic matter) that falls or is washed into the caves, and (2) energy brought into the caves by cave crickets (*Ceuthophilus* spp.) (Barr 1968, p. 48; Reddell 1993, p. 2; Lavoie *et al.* 2007, p. 114; Taylor *et al.* 2003, p. 3; 2004, p. 2; 2005, p. 97), which are found in most Texas caves (Reddell 1966, p. 33). Cave crickets forage widely in the surface habitat surrounding the cave. Karst invertebrates feed on the cave cricket eggs (Mitchell 1971, p. 251), feces (Barr 1968, pp. 51–53, Poulson *et al.* 1995, p. 226), and directly on the crickets themselves (Elliott 1994, p. 15).

Development within urbanized areas can destroy or alter the surface plant and animal communities on which karst invertebrates depend. As development increases within the cave crickets' foraging area, there may be dramatic shifts in the available food supply within the cave (Taylor *et al.* 2007, p. 7). The leaf litter and other decomposing material that make up most of the detritus from the surface plant and animal community may also be reduced or altered, resulting in a reduction of nutrient and energy flow into the cave. A study by Taylor *et al.* (2007) compared caves in urbanized areas that were impacted by development to those in natural areas and found that, even though a small area within a largely urbanized ecosystem may support a cave community where karst

invertebrates are occasionally seen, these populations are significantly lower than those found in caves in more natural, less developed ecosystems, most likely as a result of reduced nutrient input. Another study at Lakeline Cave in Travis County, Texas, was conducted in association with the issuance of a habitat conservation plan and accompanying section 10(a)(1)(B) permit issued for Lakeline Mall. That study is based on data collected from 1992 through 2011, which documented a significant decline during that 20-year timeframe in another endangered karst invertebrate, the Tooth Cave ground beetle (*Rhadine persephone*), and cave crickets as development increased (ZARA 2012, pp. 8, 10, 12). Further, at Lakeline Mall Cave, no more than three Bone Cave harvestmen have been observed during any single survey (ZARA 2012, p. 11). Also, no Bone Cave harvestmen were seen during 6 years (1993, 1999, 2001, 2006, 2009, and 2010) and 12 surveys in Lakeline Mall Cave (ZARA 2012, p. 11).

Available information in our files supports our projection in the 1988 listing rule (53 FR 36029) that development and human population would continue to increase within the range of the species. The population of the City of Austin grew from 251,808 people in 1970, to 735,088 people in 2007 (City of Austin 2007). This represents a 192-percent increase over the 37-year period. Population projections from the Texas State Data Center (2012, pp. 496–497), estimate that Travis County will increase 94 percent in population from 1,024,266 in 2010, to 1,990,820 in 2050. The Texas State Data Center also estimates an increase in human population in Williamson County from 422,679 in 2010, to 2,015,294 in 2050 representing a 377-percent increase over a 40-year timeframe. All human population projections from the Texas State Data Center presented here are under a high-growth scenario, which assumes that migration rates from 2000 to 2010 will

continue through 2050 (Texas State Data Center and the Office of the State Demographer 2012, p. 9). Urbanization and human population growth and development were identified as a threat in the original 1988 listing rule and continue to represent a threat to the species.

Factor B: Overutilization for commercial, recreational, scientific, or educational purposes. In the 1988 listing rule for the Bone Cave harvestman (53 FR 36029), we did not identify any threats under this factor. Likewise, the petition and our review of the information in our files did not identify any threats under this factor.

Factor C: Disease or predation. In the 1988 listing rule (53 FR 36029), we stated that increased human population increases the threat of predation by and competition with exotic (nonnative) and native surface-dwelling species, such as sow bugs, cockroaches, and red imported fire ants. The petition states that "[r]ecent studies suggest that fire ants may not present as significant or as lasting of a threat to the species as originally believed." The information cited regarding red imported fire ants is identified in the petition as an article by Porter and Savignano (1990), which we previously considered in our finding on the 1993 petition (59 FR 11755; March 14, 1994), and another study by Morrison (2002). The petition states that "a subsequent study by Morrison in 2002 revisited the Porter and Savignano (1990) study area 12 years later and replicated their study."

Morrison (2002, pp. 2341, 2343–2344) found that arthropod communities had rebounded to pre-RIFA [red imported fire ant]-invasion levels and that all measures of native ant and other arthropod species' diversity had returned to pre-invasion levels. Red imported fire ants were still the most abundant ant species, but not nearly as abundant as

during the initial red imported fire ants infestation. He concluded that the impacts to arthropod communities by red imported fire ants might be greatest during and shortly after the initial invasion, but long-term impacts are likely not as significant as once believed. However, we note that Morrison (2002, p. 2342) also states that "it is quite likely that red imported fire ants did contribute directly or indirectly to the disappearance or reduction in numbers of species" and that their study "should not be interpreted as an indication that detrimental effects of invasive ants will simply disappear with time." In addition, this is not "new information" as we have already reviewed these articles and considered the information they provided in the Bexar County Karst Invertebrates Recovery Plan (Service 2011, p. 12) and in our Karst Preserve Management and Monitoring Recommendations (Service 2014, p. 3), which is applicable here as all central Texas endangered karst invertebrates have similar life-history characteristics, and one of the Bexar County invertebrates (the Cokendolpher Cave harvestman) is in the same genus (*Texella*) as the Bone Cave harvestman. In addition, red imported fire ants have been found within and near many caves in central Texas and have been observed feeding on dead troglobites, cave crickets, and other species within caves (Elliott 1992, p. 13; 1994, p. 15; 2000, pp. 668, 768; Reddell 1993, p. 10; Taylor *et al.* 2003, p. 3).

Factor D: The inadequacy of existing regulatory mechanisms. The 1988 listing rule (53 FR 36029) states that "there are currently no laws that protect any of these species or that indirectly address protection of their habitat." While the petition did discuss some new ordinances that appear to have been put in place since the time of listing, we do not have enough information to indicate whether or not these State and local ordinances provide enough protection from all threats to the Bone Cave harvestman

in perpetuity.

The petition states that "the regulatory landscape includes a number of measures contributing to the conservation of the species outside of the protections afforded by the Endangered Species Act of 1973, as amended." For example, they say that protections offered though the City of Austin are adequate to protect the species in Austin, Texas. In the course of our work, we have reviewed these regulations and understand that most caves that are defined by the City of Austin's Environmental Criteria Manual as a cave are provided a 46- to 91-m (150- to 300-ft) set-back area (City of Austin 2014, p. 13-3). However, a 46-m (150-ft) or 91-m (300-ft) set-back is not adequate to meet our preserve design criteria, does not protect the cave cricket foraging area, and potentially does not include the surface and subsurface drainage basins. Further, the City of Austin's regulations are not applicable across the full range of the Bone Cave harvestman because the species occurs in Travis and Williamson Counties, including areas outside the Austin city limits.

The petition states that the City of Georgetown Water Quality Management Plan for the Georgetown salamander will offer protection to the Bone Cave harvestman. They state that this plan encourages the use of best management practices to protect water quality at Georgetown salamander locations. However, there are few Bone Cave harvestman locations that occur near Georgetown salamander locations, so any protection offered to the harvestman would be limited. Further, it is not clear from the petition whether this mechanism is voluntary, regulatory, or is currently in effect. In addition, the petition did not provide enough detail for us to evaluate all benefits this plan would provide to the Bone Cave harvestman, and it appears that participation in this plan is at

least in part voluntary.

The petition states that the Texas Commission on Environmental Quality (TCEQ) Edwards Rules provide protection to recharge features on the Edwards Plateau and that this provides protection from pollution to the Bone Cave harvestman. In a discussion of Factor D in the Bexar County Karst Invertebrates Recovery Plan (Service 2011, p. 13), we state that "the TCEQ water quality regulations do not provide much protection to the species' habitat (see 65 FR 81419–81433 for more information). For example, while some TCEQ practices provide protection from water quality impacts, others, such as sealing cave entrances for water quality reasons, can harm karst invertebrates." Sealing cave entrances can be harmful by blocking off water (leading to drying) and nutrient input to the karst invertebrate habitat. In addition, not all of the caves and mesocaverns that the Bone Cave harvestman occurs in are considered recharge features and, therefore, would not receive some of the water quality protection measures. Also, not all locations of the Bone Cave harvestman are under the jurisdiction of the Edwards Rules.

Factor E: Other natural or manmade factors affecting the continued existence of the species. In the 1988 listing rule (53 FR 36029), we stated that this species is extremely vulnerable to losses because of its severely limited range and because of its naturally limited ability to colonize new habitats. We also stated that the very small size of the species habitat units and the fragile nature of cave ecosystems make this species vulnerable to even isolated acts of vandalism. The petition states, "Inner Space Cavern demonstrates that the species can persist in caves with frequent human visitation and may be more tolerant of related habitat modification than originally believed." They also provide Three-Mile Cave and Four-Mile Cave as examples of caves that have

experienced human use yet the species persists in them. The petition contends that, since the Bone Cave harvestman exists in Inner Space Caverns, human visitation is not a threat. The petition also states that Three-mile and Four-mile Cave had graffiti from the 1890s, 1920s, and 1950s. However, no detailed information was provided to demonstrate if these caves experienced continued human use. The petition also indicates that Four-Mile Cave was inaccessible to humans prior to 2009, due to boulders blocking the entrance. In addition, the petition provided no trend analysis for these caves. As stated earlier, the observation of the species in these locations does not mean the populations at these locations have not been impacted (in a way that is short of extirpation) or can withstand the long-term impacts that are expected to occur to karst invertebrate populations in developed areas or from human visitation.

In the species 5-year status review (Service 2009, p. 18), we said, "[a]lthough climate change was not identified as a threat to *T. reyesi* in the original listing document or in the recovery plan, the species' dependence on stable temperatures and humidity levels opens the possibility of climatic change impacting this species. Therefore, while it appears reasonable to assume that *T. reyesi* may be affected, we lack sufficient certainty to know how climate change will affect this species."

The petition states that "the use of small voids or 'mesocaverns' within the geologic formations known to support occupied caves mitigates the potential threat of climate change." We acknowledge that mesocaverns may provide some protection from fluctuations in temperature and humidity that may be induced by climate change. However, the presence of mesocaverns alone will likely not be sufficient to ameliorate all of the effects that climate change may pose to this species, especially in the long run.

Karst invertebrates depend on stable temperatures and high humidity (Barr 1968, p. 47; Mitchell 1971, p. 250). The temperatures in caves are typically the average annual temperature of the surface habitat and vary much less than the surface environment (Howarth 1983, p. 372; Dunlap 1995, p. 76). If average surface temperatures increase, this could result in increased in-cave temperatures, which could affect the Bone Cave harvestman.

Increased and/or more severe storms, as well as prolonged periods of high temperatures and drought between rainfall events, associated with anticipated climate change effects may also impact the cave environment. Changes in rainfall regimes may affect the harvestman in several ways, including directly either through flooding or indirectly by modifying their habitat or nutrient availability. Changes in rainfall regimes could (1) alter the moisture levels within the caves leaving them drier between floods, which could lead to desiccation of the Bone Cave harvestman; and (2) affect the amount and timing of nutrients washed into a cave, potentially resulting in longer periods between nutrient input. These changes to drier and less suitable conditions in the caves will likely cause the Bone Cave harvestman to retreat farther into mesocaverns and away from nutrients that are thought to be located in larger cave passages (Howarth 1987, pp. 5–7), causing individuals to spend more energy trying to acquire nutrients in an already stressed environment. In addition, caves in arid regions have been shown to have smaller invertebrate populations and diversity due to less moisture and nutrient availability (George Veni, National Cave and Karst Research Institute, pers. comm. 2010). Since the Bone Cave harvestman is also sensitive to these habitat parameters, it is reasonable to predict that the effects of climate change on these habitat parameters could affect its

populations in a similar manner despite the presence of mesocaverns.

Further, stochastic (random) events from either environmental factors (for example, severe weather) or demographic factors (which come from the chance events of birth and death of individuals) exacerbate threats to the species because of its small population size (Melbourne and Hastings 2008, p. 100). The risk of extinction for any species is known to be highly inversely correlated with population size (Pimm *et al.* 1988, pp. 774–775; O'Grady *et al.* 2004, pp. 516, 518). In other words, the smaller the population the greater the overall risk of extinction. Therefore, threats to the Bone Cave harvestman are exacerbated by its small population size, which makes it more vulnerable to existing threats.

Finding

The U.S. Fish and Wildlife Service and the National Marine Fisheries Service (Services) use the rulemaking process in our administration of the Act, in particular section 4 of the Act. Section 4(b)(3) of the Act establishes deadlines and standards for making findings on petitions to conduct rulemakings under section 4. As stated above, the Services revised the regulations at 50 CFR 424.14 to clarify the procedures under which the Services evaluate petitions effective October 27, 2016 (81 FR 66462; September 27, 2016). We originally received the petition that is the subject of this document on June 2, 2014, with supplemental information received on October 6, 2016. We therefore evaluated this petition under the 50 CFR 424.14 requirements that were in effect prior to October 27, 2016, as those requirements applied when the petition and supplemental information were received.

We have reviewed the petition, including all accompanying materials, and

evaluated readily available, related information in our files. The results of the 2009 5-year review and the assessment of threats in the five factor analysis presented in this 90-day finding do not indicate that the original classification was made in error. The petitioners have primarily based their contention that the species can thrive in developed areas on information that we have previously considered and rejected while working on previous documents (Service 2009, 2012). Petitioners present limited new information, such as the fact that four occupied caves have been discovered since the 5-year status review. In addition, petitioners assert that seven other caves are occupied. However, we lack, and the petition did not provide, locality information or taxonomic verifications related to these potential additional locations of the species. The other arguments presented in the petition lack a large enough sample size to produce population trend information for the Bone Cave harvestman. The petition provided no trend analysis to indicate that this species can withstand the threats associated with development or climate change over the long term. In addition, these threats, particularly those related to development, appear to be increasing in severity. Based on our review and evaluation, we find that the petition does not present substantial scientific or commercial information indicating that the delisting of the Bone Cave harvestman may be warranted due to recovery, extinction, or error in the original scientific data at the time the species was classified or in our interpretation of the data.

Although this finding ends our formal consideration of the petition, we are in the process of conducting a species status assessment and 5-year status review. Specifically, section 4(c)(2)(A) of the Act requires us to review each listed species' status at least once every 5 years. On April 15, 2015, we published a notice in the Federal Register initiating

this review (80 FR 20241). The purpose of a 5-year review is to determine whether listed species should be removed from the list or changed in status under the Act. In this case, we are developing a species status assessment as a tool to inform the 5-year status review. The 5-year review will consider whether the species status has changed since the time of its listing or its last status review and whether it should be reclassified as threatened or delisted. We invite the public, including the petitioners and other interested parties, to submit new data and information for consideration in this ongoing process.

Much progress has been made toward recovery in the North Williamson and Jollyville Plateau Karst Fauna Regions. We encourage interested parties to continue to gather data and implement conservation actions across the range of the Bone Cave harvestman that will further assist with the conservation of this species. If you wish to provide information regarding the Bone Cave harvestman, you may submit your information or materials to the Field Supervisor, Austin Ecological Services Field Office (see **ADDRESSES**) at any time.

References Cited

A complete list of references cited is available on the Internet at *http://www.regulations.gov* and upon request from the Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Authors

The primary authors of this document are staff members of the Austin Ecological Services Field Office.

Authority

The authority for this action is the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: ______________________________

____

Director, U.S. Fish and Wildlife Service

Authority

The authority for this action is the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: MAR 2 0 2017

James W. Kurth

James W. Kurth

Acting *Director, U.S. Fish and Wildlife Service*

Administrative Record Excerpt 2

M003456 - M003520

Petition to delist the Bone Cave harvestman (*Texella reyesi*) in accordance with Section 4 of the Endangered Species Act of 1973

Petition to delist the Bone Cave harvestman (*Texella reyesi*) in accordance with Section 4 of the Endangered Species Act of 1973

PETITION TO DELIST THE BONE CAVE HARVESTMAN (*TEXELLA REYESI)* IN ACCORDANCE WITH SECTION 4 OF THE ENDANGERED SPECIES ACT OF 1973

Petitioned By:

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June 02, 2014

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EXECUTIVE SUMMARY

The federally endangered Bone Cave harvestman (*Texella reyesi*) is a terrestrial karst invertebrate that occurs in caves and voids north of the Colorado River in Travis and Williamson counties, Texas. The U.S. Fish and Wildlife Service (USFWS) listed *T. reyesi* as endangered in 1988 on the basis of only five to six known localities that occurred in a rapidly developing area. Little was known about the species at the time, but the USFWS deemed listing was warranted to respond to immediate development threats. The current body of information on *T. reyesi* documents a much broader range of known localities than known at the time of listing and resilience to the human activities that USFWS deemed to be threats to the species.

Status of the Species

- An increase in known localities from five or six at the time of listing to 172 today.
- Significant conservation is in place with at least 94 known localities (55 percent of the total known localities) currently protected in preserves, parks, or other open spaces.
- Regulatory protections are afforded to most caves in Travis and Williamson counties via state laws and regulations and local ordinances.
- Biologists continue to discover new, occupied localities and this trend is likely to continue as more areas are explored and more caves are discovered.

Review of Endangered Species Act Listing Factors

- Development activities on the surface may not result in the significant loss or degradation of habitat for *T. reyesi* as originally thought. Several examples of continued species persistence in developed areas include: Inner Space Caverns, Sun City caves, Three-Mile Cave, Four-Mile Cave, and Weldon Cave.
- Inner Space Caverns demonstrates that the species can persist in caves with frequent human visitation and may be more tolerant of related habitat modifications than originally believed.
- Recent studies suggest that fire ants may not present as significant or as lasting of a threat to the species as originally believed.
- The regulatory landscape includes a number of measures contributing to the conservation of the species outside of the protections afforded by the Endangered Species Act of 1973, as amended.
- The use of small voids or "mesocaverns" within the geologic formations known to support occupied caves mitigates the potential threat of climate change.

This petition provides several examples of other delisting actions by the USFWS in recent years, highlighting the rationale behind these prior actions and identifying similarities with the circumstances of *T. reyesi*. These provide historical evidence that the USFWS has delisted species on the basis of the original data in the listing rule being in error, as a result of new information demonstrating that the true range and population of the species is more expansive than previously known, and on the basis of species recovery, even if the criteria in published recovery plans were not fully met.

The Petitioners believe that delisting *T. reyesi* is warranted on the basis of both 1) significant conservation efforts achieving recovery, 2) significant increases in the number of known localities and the size of the species' range, and 2) new information and analysis indicating the existence and/or magnitude of previously identified threats do not support a conclusion that the species is at risk of extinction now or in the foreseeable future.

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We, the Petitioners, respectfully submit this petition to delist the federally endangered Bone Cave harvestman *(Texella reyesi)* to the U.S. Fish and Wildlife Service (USFWS) for consideration pursuant to Section 4 of the Endangered Species Act (ESA) of 1973, as amended.

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1.0 PETITIONED ACTION

The Petitioners respectfully submit this petition to delist the federally endangered Bone Cave harvestman *(Texella reyesi*) to the U.S. Fish and Wildlife Service (USFWS) for consideration pursuant to Section 4 of the Endangered Species Act (ESA) of 1973, as amended.

Since the 1988 listing, under the name *Texella reddelli,* a substantial amount of new scientific and commercial information has become available that demonstrates that *T. reyesi* is not at risk of extinction now or in the foreseeable future and that the protections of the ESA were not and are not warranted. The Petitioners request that the Secretary of the Interior (Secretary), acting by and through the USFWS, evaluate this petition to delist the *T. reyesi* on the basis of the best available scientific and commercial data pursuant to Section 4 of the ESA.

Several of the Petitioners believe that species inappropriately receiving the protections of the ESA cause significant economic harm to landowners who are prevented from using their land and to local governments who need to provide necessary community services. Others believe that the objectives of the ESA are best served by focusing limited conservation resources on species that truly warrant the protections of the ESA. All Petitioners believe that *T. reyesi* should no longer be listed as threatened or endangered under the ESA.

Pursuant to ESA section 4(b)(3)(A), the question USFWS must determine at this stage is "whether the petition presents substantial scientific or commercial information indicating that the petitioned action may be warranted." This is a relatively low-threshold burden of proof. For the purposes of this decision, "'substantial information' is that amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted." 50 CFR 424.14(b)(1).

2.0 BONE CAVE HARVESTMAN SPECIES OVERVIEW

In the 25 years since the final rule listing *T. reyesi* as endangered in 1988, there has been much progress toward developing a scientific basis for understanding the biology and ecology of troglobitic species in Texas. Much of the available scientific data have been developed through monitoring activities associated with preserve management and project reviews related to ESA Section 10 permits and Section 7 consultations. While much of this research is site specific, it provides the basis for the current scientific and commercial data on, and understanding of, *T. reyesi*.

T. reyesi is a pale orange harvestman with absent retina. The species was identified by Ubick and Briggs (1992:211) as extremely polymorphic, particularly in its troglomorphic characteristics. For example, *T. reyesi* may have well developed cornea or the cornea may be reduced or absent altogether. Ubick and Briggs (1992:211) identified that the species is more troglomorphic in the northern reaches of its distribution. In other words, in the southern part of the range individuals have partial corneas, while in the north morphological evidence of any remnants of eye development is completely absent.

3.0 BONE CAVE HARVESTMAN REGULATORY HISTORY

The USFWS first listed *T. reyesi* as endangered under the ESA in 1988 under the name Bee Creek Cave harvestman (*T. reddelli*) (53 Fed. Reg. 36029). In 1993, the USFWS recognized *T. reyesi* as a separate species and published a final rule extending the endangered listing to this new species (56 Fed. Reg. 43818). This section is provided as a historical and regulatory overview of these and subsequent actions describing USFWS accepted data pertaining to *T. reyesi*. The justification for delisting, including an assessment of the current status, range, and distribution of the species, is provided in Section 5.0 of this Petition.

3.1 FINAL LISTING RULE (1988)

On September 6, 1988, the USFWS published a final rule to list as endangered five species of karst invertebrates known to occur only in Travis and Williamson counties, Texas (53 Fed. Reg. 36029). This final rule, which became effective on the date of publication, extended the protection of the ESA to the Tooth Cave pseudoscorpion *(Microcreagris texana)*, the Tooth Cave spider *(Leptoneta myopica)*, the Bee Creek Cave harvestman *(Texella reddelli)*, the Tooth Cave ground beetle *(Rhadine persephone)*, and the Kretschmarr Cave mold beetle (*Texamaurops reddelli)*.

Pursuant to the listing factors identified in the ESA, the USFWS provided the following justifications for the listing of these species as endangered (which now also pertain to *T. reyesi*) (53 Fed. Reg. 36031):

- **Listing Factor A (the present or threatened destruction, modification, or curtailment of its habitat or range):** "The primary threat to the five species comes from the potential loss of habitat owing to ongoing developmental activities." At that time, the USFWS assessment was directly related to "a major residential, commercial, and industrial development" that affected the entire known range of several of the species and a large portion of the habitat of the species we know today as *T. reyesi.* The USFWS described the potential threats from development activities as including collapsing or filling in caves during construction; the alteration of drainage patterns to caves (either increasing or decreasing water flow); increasing the flow of sediment, pesticides, fertilizers, and general urban run-off into caves; and increased human visitation and vandalism.

- **Listing Factor B (overutilization for commercial, recreational, scientific, or educational purposes):** The USFWS determined that "no threat from overutilization of these species is known to exist" at the time of listing; however, collection for scientific or educational purposes could become a threat if localities become generally known.

- **Listing Factor C (disease or predation):** The USFWS determined that increased human population increases the "problems of predation by, and competition with, exotic (non-native) species," including sowbugs, cockroaches, and fire ants.

- **Listing Factor D (the inadequacy of existing regulatory mechanisms):** The USFWS determined that these species were threatened by a lack of existing regulatory protections, based on a finding that "there are currently no laws that protect any of these species or that directly address protection of their habitat."

- **Listing Factor E (other natural or manmade factors affecting its continued existence):** USFWS discussed the limitations placed on these species by a lack of mobility from one habitat to another and stated "moisture regimes, food supply, and other factors may also limit subsurface migrations." The USFWS identified changes to inner-cave climate from surface alterations and vandalism of caves as potential threats.

In support of the 1988 final listing rule, the USFWS relied on only seven referenced data sources to substantiate the listing of the five species. Of these sources, only one source was less than ten years old at the time of the final rule, and only the Goodnight & Goodnight paper (1967) had any reference specific to *T. reddelli*. In the final rule, *T. reddelli* was confirmed from only five caves and believed to exist, but not confirmed, in a sixth. The known range of the species extended a distance of approximately 21 miles along the edge of the Edwards Plateau (75 square miles). The USFWS decision to list *T. reddelli* (later identified as *T. reyesi; see* Section 3.2) was based on very limited information about the species (including basic taxonomy) and was prompted by concerns about potential adverse effects of development activities at a time when the link between such activities and actual effects on the species was largely unknown.

3.2 TAXONOMIC SPLIT AND TECHNICAL CORRECTION (1993)

In response to a published taxonomic study by Ubick and Briggs in 1992, the USFWS determined in 1993 that *T. reddelli* was actually two distinct species (56 Fed. Reg. 43818). The newly identified species, *T. reyesi*, was afforded the same protections under the ESA as *T. reddelli*. In this final rule (identified as a "technical correction"), the USFWS states that "both of these species continue to face the same general threats identified in the original listing of the Bee Creek Cave harvestman [*T. reddelli*]" (56 Fed. Reg. 43819). The USFWS acknowledged that by "including newly discovered localities" of the *T. reyesi* the known range of the species expanded from 21 miles to 31 miles along the edge of the Edwards Plateau. However, the USFWS did not elaborate on the number or significance of these newly discovered localities.

Ubick and Briggs (1992:207; 211) identified 24 known *T. reyesi* locations and four *T. reddelli* locations. Of the caves in the original listing, only one of those locations (Bee Creek Cave) ultimately contained *T. reddelli* and the other four or five localities (Tooth Cave, McDonald Cave, Weldon Cave, Bone Cave, and potentially in Root Cave) contained the species now known as *T. reyesi*. The 1993 technical correction does not include an analysis of the ESA listing factors specifically applicable to *T. reyesi* nor the expanded range and distribution information. In its decision to list this newly identified species as endangered with extinction, the USFWS did not assess any new scientific or commercial data on the species beyond the taxonomic revision.

In the 1993 final rule, the omission of any assessment of available substantive scientific data beyond Ubick and Briggs (1992) was an oversight of substantial significance to the actual appropriateness of the listing. At the time the final rule was published, progress was well underway toward developing the 1994 Endangered Karst Invertebrates (Travis and Williamson counties, Texas) Recovery Plan (1994 Recovery Plan). The 1994 Recovery Plan (which addresses *T. reyesi* and six other listed karst invertebrates) includes an extensive nine-page list of references, including 32 publications and reports that are of relevance to *T. reyesi*. None of these sources were explicitly considered in the determination to extend the protections of the ESA to *T. reyesi*. This means that at the time of the 1993 technical correction, a substantial body of new information was available to the USFWS that was not considered or analyzed in the final listing rule for *T. reyesi*, indicating that the decision was not fully supported by the application of the best available scientific data available at the time.

3.3 PETITION TO DELIST AND NEGATIVE 90-DAY FINDING (1994)

On June 7, 1993, a petition to delist seven Texas karst invertebrates, including *T. reddelli,* (and later clarified to include *T. reyesi)* was submitted to the USFWS. In 1994, the USFWS issued a 90-day finding on that petition and determined that the petition, submitted by Judge John C. Doerfler of Williamson County, did not present substantial scientific data to support the delisting of any of the seven species identified.

In its 90-day finding, the USFWS determined that *T. reyesi* "is currently known from about 69 locations (60 confirmed, 9 tentative)" in Travis and Williamson counties (59 Fed. Reg. 11755). Of these localities, nine were protected at the time of the negative 90-day finding, including "three [that] are TSNL (Texas System of Natural Laboratories) caves, two [that] are in City of Austin preserves, two [that] are in City of Georgetown preserves, and two [that] were acquired as mitigation for a development project" (59 Fed. Reg. 11755). The 90-day finding includes multiple references to a review of the petition conducted by James Reddell (foremost expert on Texas cave fauna, Interim Curator of Entomology at the Texas Memorial Museum) entitled "Response to the Petition to Delist Seven Endangered Karst Invertebrates."

In the 90-day finding, the USFWS provided an assessment of the five listing factors previously identified in the ESA in reaching their finding. The USFWS maintained that "the primary threat to these species

comes from loss of habitat due to development activities" (59 Fed. Reg. 11756). The finding defers to the 1988 final rule for a specific discussion of the potential impacts of development activities. While the 90-day finding acknowledges that the known localities of *T. reyesi* have increased in the six years between 1988 and 1994, the USFWS concludes that "the degree of threat of habitat destruction or modification remains significant, and may have increased, throughout the range of each species" (59 Fed. Reg. 11756). USFWS provides this generalization without citing any scientific or commercial data to support the assertion, and without providing any specific examples of karst invertebrate habitat actually being lost to development activities. The USFWS did not cite any census data specific to *T. reyesi* populations that would have provided a quantitative basis for the continued support of the agency' s original assertions.

Interestingly, the 1994 delisting petition included a list of known occupied caves that had been impacted by development activities yet continued to support the presence of listed species. The USFWS was not swayed by these data. However, the USFWS "agrees with the Petitioners that there is little quantitative data available on the direct effects" of these activities (59 Fed. Reg. 11756). It is important to note that the finding does not *disagree* with the list of examples presented in the petition. Rather, the USFWS states its surmise that "in most cases, not enough time has elapsed since the disturbance to detect an effect on the karst invertebrates." The USFWS seemingly makes the assumption that population declines will occur over time, but implies that if an adequate amount of time can be shown to have passed since the onset of these activities without recordable decline in the species at these sites, it could be concluded that these threats are not as severe as anticipated in the 1988 final rule and subsequent findings (59 Fed. Reg. 11756).

In the 90-day finding, the USFWS re-emphasized the threat presented by red imported fire ants (RIFA). The USFWS references Porter and Savignano (1990) to support the statement that "overall arthropod diversity drops" where RIFA are present (59 Fed. Reg. 11757). The USFWS also references a list developed by James Reddell and included in his review of the petition identifying nine cave-dwelling species known to have been preyed on by RIFA, none of which are *T. reyesi*. The USFWS concluded that controlling RIFA is a challenging yet necessary component to ensuring the continued viability of cave-dwelling species.

In the 90-day finding, the USFWS briefly discusses existing regulatory mechanisms relevant to the petitioned species and concludes that they were not sufficient to protect the species. The USFWS concluded that the known preserves identified in the petition did not include the entire extent of the drainage basins supplying moisture to the caves or did not have protections afforded in perpetuity. The USFWS did not identify any concerns relating to other natural or manmade factors specific to *T. reyesi*, but did identify a loss of genetic diversity as a concern for some of the other species included in the finding. The USFWS concluded that "these species continue to require the protection of the Act because of their extremely small, vulnerable, and limited habitats located within an area that is experiencing continued pressures from economic and population growth" (59 Fed. Reg. 11758). However, an "extremely small, vulnerable, and limited" habitat or range is not one of the listing factors identified in the ESA. It is the burden of the USFWS to identify how the listing factors threaten the species with extinction in the foreseeable future, and simply identifying that economic and population growth is likely to continue does not accomplish that task without specific examples of declining populations due to these activities.

Moreover, in his review of the delisting petition, James Reddell specifically states that "an argument could perhaps be made that because of its greater range *Texella reyesi* is not endangered" (Reddell 1993:11). This statement is completely ignored in the USFWS discussion on Reddell' s response to the petition.

3.4 ENDANGERED KARST INVERTEBRATES RECOVERY PLAN (1994)

Section 4(f)(1) of the ESA requires that the Secretary "develop and implement plans… for the conservation and survival of endangered and threatened species listed" pursuant with the ESA, "unless he finds that such a plan will not promote the conservation of the species." Consistent with these definitions, the goal of recovery plans is to achieve a level of conservation for a listed species that removes the need for protection under the ESA. Section 4(f)(1)(B)(ii) states that recovery plans shall, to the maximum extent practicable, set "objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of [the ESA], that the species be removed from the list."

The status of *T. reyesi* was addressed in the 1994 Recovery Plan approved by the USFWS. At the time of the 1994 Recovery Plan, *T. reyesi* was confirmed in 60 caves with an additional nine pending confirmation and a geographic range including 135 square miles. This significant increase in known localities and range from the time of the 1988 listing (from 6 to 60–69 caves and 75 to 135 square miles) is consistent with the range and distribution known and discussed by the USFWS in its 90-Day Finding response to the 1993 delisting petition and in James Reddell' s response to the delisting petition.

Since the 1994 Recovery Plan addresses seven invertebrate species, much of the analysis is general in nature in an attempt to encompass all the species represented in the Plan. Referring to all of the included species, the USFWS summarizes that "no population estimates are currently available for any of the species due to their secretive habits, rarity, and inaccessibility" (USFWS 1994:27).

Other than general taxonomic descriptions, the species-specific biological information and data relating to threats to the species that are provided for *T. reyesi* pertain solely to monitoring data gathered from Lakeline Cave and Temples of Thor Cave and is not representative of the status of the complete population. In evaluating the listing factors in relation to *T. reyesi*, the USFWS states that four known occupied caves had been filled, one of which was later reopened. The USFWS describes other related threats to the covered species including the alteration of drainage patterns, the alteration of surface plant and animal communities, contamination, human visitation and vandalism, the invasion of fire ants, and mining activities. While the USFWS provides examples of *T. reyesi*-occupied caves that occur in the vicinity of these threats, they do not provide data on any measurable negative impacts to *T. reyesi* resulting from this proximity. Nor does the USFWS consider in the listing factor analysis the beneficial conservation actions implemented for the species.

Karst Fauna Regions, Karst Zones, and Karst Fauna Areas

The 1994 Recovery Plan is heavily dependent upon the Karst Fauna Region (KFR) hypothesis developed by George Veni and Associates in 1992 (Veni and Associates 1992). The KFR principle was developed through a study conducted with ESA Section 6 funding to assess "geologic controls on cave development and distribution of karst fauna in the vicinity of Travis and Williamson counties" (USFWS 1994:67). The result was the delineation of 11 distinct areas named "karst fauna regions" within Travis, Williamson, Hays, and Burnet counties based on "geologic continuity, hydrology, and the distribution of 38 rare troglobites" (USFWS 1994:67). When the 1994 Recovery Plan was developed, *T. reyesi* was known from six KFRs: the North Williamson County, Georgetown, McNeil/Round Rock (originally identified as two distinct KFRs, but considered as one in the 1994 Recovery Plan), Cedar Park, Jollyville Plateau, and Central Austin KFRs.

In addition to delineating the KFRs, Veni and Associates (1992) identified zones in Travis and Williamson counties that estimated the relative likelihood that listed karst invertebrate species were present in each zone. These "Karst Zones" are described as follows in the 1994 Recovery Plan:

> Zone 1: Areas in the Edwards Group limestones that are known to contain listed species;

Zone 2: Areas that may contain listed species or other endemic fauna;
Zone 3: Areas that probably do not contain any listed species or their habitat; and
Zone 4: Areas of non-cavernous rock and thus do not contain caves or other karst features.

The 1994 Recovery Plan identifies the known distribution of each of the included species by occupied cave. This effectively demonstrates that the known range of *T. reyesi* far exceeded the known range for the other six species addressed in the recovery plan (Table 1). This distribution information further demonstrates the significant increase in known localities, from the five confirmed localities in 1988 to the 69 confirmed and pending localities known at the time the 1994 Recovery Plan was approved. Despite the acknowledgment of these new data, including the fact that *T. reyesi* occurs in six of the eight KFRs, there was no discussion on how the information may warrant unique consideration in determining appropriate recovery criteria for *T. reyesi*.

Table 1. Endangered karst invertebrate locations as of 1994 in Travis and Williamson Counties as Identified by William Elliot and James Reddell for Inclusion in the 1994 Recovery Plan (USFWS 1994:29)

Karst Invertebrate Species	Occupied Localities Travis County	Occupied Localities Williamson County	Total
Texella reyesi	19	50	69
Texella reddelli	7	0	7
Tartarocreagris texana	4	0	4
Neoleptoneta myopica	4	0	4
Rhadine persephone	12	15	27
Texamaurops reddelli	4	0	4
Batrisodes texanus	0	5	5

The 1994 Recovery Plan bases the downlisting criteria for the Travis and Williamson counties karst invertebrates on the permanent protection of Karst Fauna Areas (KFAs) within each of the KFRs where a species is known to occur. The 1994 Recovery Plan states that KFAs should be selected on the "ability to ensure long-term protection, current level of habitat disturbance, past and present land use, presence of other rare or candidate species, ease of protection (landowner cooperation), and, where applicable, importance to the regional groundwater system" (USFWS 1994:80). At the time the 1994 Recovery Plan was written, there was no specific design for the size and configuration of a KFA. The 1994 Recovery Plan instead provided that those specific determinations should be site-specific, but should include an area large enough to "maintain the integrity of the karst ecosystem on which each species depends" (USFWS 1994:82).

The 1994 Recovery Plan recommends that downlisting of any of the listed karst invertebrates be considered when three KFAs within each KFR where the species is known to occur (if opportunities for at least three exist) are protected in perpetuity (USFWS 1994:76). However, where opportunities for three KFAs per KFR are not known to exist, the USFWS indicates that two protected KFAs (or even only one, if it is the only one available) could be sufficient for downlisting, provided that at least two KFAs for that species are protected range wide (USFWS 1994:77). Given that *T. reyesi* clearly has the most known localities of the species included in the 1994 Recovery Plan, occurring across six KFRs and at 172 known localities, this species would require more protected KFAs (18 total) than the other species in order to warrant downlisting under the recovery guidelines (USFWS 1994:79), even though the 1994 Recovery Plan indicates that a lesser standard could be sufficient for protection of the species.

Requiring the species with the most known localities and widest distribution to also have the most formally protected KFAs provides a level of conservation that exceeds what is necessary to ensure the perpetual protection of the species, particularly when compared to the recovery guidelines provided for the rarest of the species. The 1994 Recovery Plan does not provide any biological evidence why having more than two KFAs for a more abundant species is necessary for the species' long-term survival, when the USFWS does not require this level of conservation for species that are considered to be rarer. Nor does the USFWS provide evidence regarding how the determination of three KFAs within each KFR is necessary to contribute to long-term recovery. Rather, it seems logical that if rare species with only two known localities can be feasibly protected to the point of downlisting when those two localities are protected, then the dozens of protected localities for *T. reyesi* that are distributed across six KFRs should also warrant downlisting consideration.

Implications of the Bexar County Recovery Plan Minority Report

In 2009, during the drafting of the Bexar County Karst Invertebrate Recovery Plan, the use of KFRs was chosen as the preferred method for assessing the recovery of related karst invertebrates in the greater San Antonio area. A minority report was provided to the USFWS by Dr. Kemble White, who served as a member of the Recovery Team that outlined scientifically supported counter arguments to the use of KFRs in the Bexar County Recovery Plan. The minority report cited a body of peer-reviewed literature that was not included for consideration by the Bexar County Recovery Team. In summation, this literature shows that actual species distribution is not represented by the KFR hypothesis and encourages the USFWS to consider alternative methods for determining appropriate distribution for recovery. While White does not argue that distinct regions cannot be delineated to measure recovery, he clarifies that "they are likely different for each species group" rather than uniform as described through the KFRs (White 2009:3).

According to White (2001; 2006; 2009) the weakness behind the KFR concept in the Bexar County system is based on insufficient sampling efforts to substantiate the KFR delineation, boundaries being developed without definitive taxonomic evidence to support those boundaries, a complete failure to consider alternative ways to define species boundaries, and biased data in the endemism index. White argues that given the normal trajectory of a significant increase in available species data following a listing action by the USFWS, and that a "great majority of useful data have been generated and published since the nine Bexar County karst invertebrates were listed," those data should be applied to revise or discard the existing KFR concept in Bexar County (White 2009:5). This is based on scientific literature that shows that "the KFR hypothesis has been retested, both directly and indirectly, and the new data consistently demonstrate that the KFR concept does not explain the biogeographical origins or distribution of the Bexar County troglobites" (White 2009:5). The Petitioners encourages the USFWS to consider the peer-reviewed data regarding the use of KFRs in determining recovery that is referenced in this petition.

While most of the available literature on this subject involves research specific to Bexar County, the same logic can be applied to the KFRs used in Williamson and Travis counties. This is supported by the consideration of the Bexar County Karst Invertebrate Recovery Plan in the 5-Year Status Review for *T. reyesi* completed by USFWS in 2009. Peer-reviewed literature that refutes the relevance and scientific application of the current KFRs must be considered in this petition. This literature demonstrates that within the body of best available scientific and commercial data there are supported arguments against the use of KFRs as the primary tool for measuring species recovery. Given this documented uncertainty, if the data demonstrate a significant increase in a species' range and this increase is accompanied by a sustaining number of protected populations and a reduction of the impacts resulting from potential threats, that species should be delisted regardless of the distribution of those protected localities. This is

consistent with the regulatory definition of recovery as described in the ESA and outlined in listing decisions approved by the USFWS (some examples are provided in Section 4 of this petition).

Challenges Associated with Multi-Species Recovery Plans

The 1994 Recovery Plan is a multi-species plan that includes little species-specific information pertaining to *T. reyesi*. While the USFWS regularly develops multi-species recovery plans in an effort to achieve high efficiency and more cohesive strategies to address threats to species, there are several studies that have determined that the current protocol for developing multi-species plans, especially the monitoring and adaptive management component of these plans, is not in the best interest of the individual species or in meeting the conservation objective of the ESA for individual species (Boersma et al. 2001; Clark et al. 2002).

A study conducted in 2001 by Boersma et al., "found that species from single-species plans were four times more likely to be improving in status than species from multi-species plans" (Clark et al. 2002:656). Clark et al. (2002) subsequently developed a statistical method for evaluating multi-species and single-species plans to test the findings of Boersma et al. (2001). The Clark study overwhelmingly confirmed the work of Boersma et al., concluding that "by nearly all measures in this and other papers analyzing the recovery plan project database, single-species recovery plans provide a better foundation for recovery efforts than multi-species plans" (Clark et al. 2002:660). In an effort to identify why there exists such a significant difference in the success rate, the Clark study identified two primary potential causes: (1) the effectiveness of the plans is directly related to the biological nature of the species and (2) by lumping multiple species into one plan, there is no attention focused to individual species' needs and therefore the recovery goals may not be equally appropriate or beneficial to each species in the plan.

Clark assesses that "the extent of species-specific biological understanding is greater in single-species than multi-species plans," which is supported by the idea that "the USFWS has lumped species into multi-species plans simply because it had insufficient information about the individual listed species to draft adequate single-species plans" (Clark et al. 2002:660).

Given these assumptions, it is reasonable to assume that the 1994 Recovery Plan does not include a complete consideration of the unique biological needs of *T. reyesi*. Evidence indicates that a species benefits from being considered independently and not as part of a multi-species effort. There has been a significant increase in the available information relating to *T. reyesi* since the development of the 1994 Recovery Plan that indicates that the levels of recovery applied generally for all seven species does not translate into appropriate recovery guidelines for *T. reyesi*.

The introductory section of the 1994 Recovery Plan includes a disclaimer that concludes "approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks" (USFWS 1994:i). This disclaimer explicitly acknowledges that should a preferred method for evaluating recovery or new analysis of the listing factors utilizing new available scientific data become available, downlisting/delisting should be considered regardless of progress towards achieving the specific conservation objectives outlined in the 1994 Recovery Plan.

3.5 5-YEAR STATUS REVIEW (2009)

Fifteen years after the release of the 1994 Recovery Plan, the USFWS completed a 5-year status review (Five-Year Review) of *T. reyesi* in 2009 and, remarkably, in spite of new data documenting the increased number of protected locations for the species, arbitrarily determined that no change in listing status was warranted. The Five-Year Review does not evaluate any of the ESA listing factors and provides no analysis of new scientific or commercial data in relation to those factors. While it does confirm that there were 168 known occupied caves containing *T. reyesi* distributed across all KFRs, a substantial increase

over those known at the time of the 1994 Recovery Plan, it does not evaluate the implications of these additional known localities on the species' risk of extinction.

While the Five-Year Review does incorporate several new references into its works cited, the resources provided are primarily related to various Section 10 consultations that have occurred relative to the species, primarily in Travis County. It is likely that the resources included in the Five-Year Review could have yielded an assessment of the species' status in relation to the listing criteria, but the USFWS made no effort to do so in their assessment. As a result, the Five-Year Review is ultimately a listing of known cave locations that fails to provide any scientific or quantitative assessment of the species' status in relation to the listing criteria, even though abundant data were available.

Inadequate Consideration of Protected or Stable Sites

In the Five-Year Review, the USFWS exclusively based its evaluation of species status on the progress (or not) towards attaining the recovery criteria outlined in the 1994 Recovery Plan, which are based on the acquisition and management of a certain number of KFAs. It acknowledges that while there was one KFA for *T. reyesi* recognized by the USFWS (Priscilla's Well KFA), an additional 28 areas were potentially eligible as KFAs. These tracts were not recognized by the USFWS as KFAs at the time of the Five-Year Review due to a lack of information regarding surface/subsurface drainage basins, insufficient protected acreages around features, and/or lack of commitments for ongoing management activities. The Five-Year Review provides an overview of each of these 28 opportunities and the known information that may warrant their consideration as a KFA. Caves identified as having KFA potential in the Five-Year Review are identified in Appendix A and section 5.2.4 of this petition. These 29 approved, potential, or de facto KFAs are locations where the effective threats to the species are sufficiently low as to warrant consideration as “recovery quality” conservation areas. The number of these essentially stable sites is in excess of the number of protected sites deemed necessary for the species in the 1994 Recovery Plan and are distributed across five of the KFRs known to include *T. reyesi*.

Inappropriate Reliance on a Narrow Set of Data

The Five-Year Review states that the USFWS “mostly relied on information summarized and cited in Balcones Canyonlands Preserve (BCP) Annual Report and the BCP cave assessment” (USFWS 2009:1). Other predominant references include the draft Bexar County Karst Invertebrate Recovery Plan and the 1994 Recovery Plan. The stated reliance on these information sources is problematic since a strong majority of the known occupied caves for *T. reyesi* are located in Williamson County and not represented in the BCP reports which cover Travis County. Further, there are no known locations of *T. reyesi* in Bexar County, which represents an altogether different karst system inhabited by an altogether different group of karst invertebrate species. The 1994 Recovery Plan, as described above, includes very little species-specific information about *T. reyesi* and relies on a recovery framework (the KFR and KFA constructs) that may not accurately reflect the conservation needs of the species.

Climate Change

The Five-Year Review briefly considers the potential threat of climate change in its analysis. Climate change is not addressed as a direct threat in either the 1988 or 1993 listing rules for *T. reyesi* and its discussion in the status review is minimal. The USFWS states that “to date, these changes do not appear to have had a negative impact on *T[exella] reyesi*” (USFWS 2009:18). The USFWS acknowledges that potential impacts of climate change are unknown and that they “lack sufficient certainty to know how climate change will affect this species” (USFWS 2009:18). Since the discussion on climate change is speculative and completely lacks supportive data, it is not a substantive argument for continued listing.

3.6 ESA Section 7 and Section 10 Consultations

The USFWS has issued or completed several ESA Section 10 incidental take permits and Section 7 consultations that address *T. reyesi*. Some (but certainly not all) of these actions include:

- Four Points Property Section 10 Permit (PRT-808694)
- Grandview Hills Property Section 10 Permit (PRT-815447)
- Comanche Canyon Ranch Section 10 Permit (TE-004683-0)
- Sultan and Kahn Section 10 Permit (TE-035525-0)
- Russell Park Estates Section 10 Permit (TE-051567-1)
- Simon Lakeline Mall Section 10 Permit (TE-762988)
- Williamson County Regional Habitat Conservation Plan Section 10 Permit (TE-181840-0)
- Balcones Canyonlands Conservation Plan Section 10 Permit (PRT-788841)
- Hart Triangle (GDF Realty Investments) Section 10 Permit (TE-027690-0)
- Shadow Canyon (San Gabriel Harvard Limited Partnership) Section 10 Permit (TE-116313-0)
- State Highway 195 in Williamson County Section 7 Consultation (21450-2006-F-0132)
- Brushy Creek MUD Section 7 Consultation (2-15-F-2002-0453)

Each of these consultations resulted in the establishment of mitigation preserve land that includes the protection in perpetuity of known *T. reyesi* localities. These represent part of the at least 8,413 acres of protected lands with 94 *T. reyesi* occupied caves discussed further in Section 5.2.4 and Appendix B of this petition.

4.0 DELISTING CRITERIA, PROCESS, AND HISTORICAL PRECEDENTS

Delisting a species from the protections of the ESA may occur as a result of achieving recovery, species extinction, or new analysis that otherwise indicates that the original listing was in error. Since 1967, 59 species have been delisted (51 domestic and 8 foreign species). Of these, 18 were delisted because the original data were found to be in error, 31 have been recovered, and 10 have gone extinct (USFWS 2013a; NOAA 2013).

4.1 Recovery and Relationship to Recovery Plans

The Policy and Guidelines for Planning and Coordinating Recovery issued by the USFWS in 1990 defines recovery as “the process by which the decline of an endangered or threatened species is arrested or reversed, and threats to its survival are neutralized, so that its long-term survival in nature can be ensured. The goal of this process is the maintenance of secure, self-sustaining wild populations of the species” (USFWS 1990:1). While there is a regulatory basis for the development of recovery plans, there is no requirement that recovery plans be implemented. **It is also important to recognize that neither the ESA nor the USFWS regulation establishes that recovery plans act as the sole determinant of a species' progress towards achieving recovery.**

For example, in its final rule to delist the Lake Erie water snake in 2011, the USFWS states that “recovery plans are intended to provide guidance to the USFWS, States, and other partners… they are not regulatory documents and cannot substitute for the determinations and promulgation of regulations required under 4(a)(1) of the Act” (76 Fed. Reg. 50681). In regard to implementation of recovery plans, the USFWS identifies that “there are many paths to accomplishing recovery of a species, and recovery may be achieved without all criteria being fully met” (76 Fed. Reg. 50681). Moreover, “the determination to remove a species from the Federal List of Endangered and Threatened Wildlife is ultimately based on an

analysis of whether a species is no longer endangered or threatened" (76 Fed. Reg. 50681). Therefore, a species may be delisted on the basis of recovery even if the specific recovery criteria identified in the species' recovery plan have not been met.

Other examples of species that have been delisted on the basis of recovery not necessarily defined by strict adherence to published recovery plan criteria include the following:

- **Columbian White-tailed Deer (*Odocoileus virginianus leucurus)*, Douglas County distinct population segment) (68 Fed. Reg. 43647) -** In 2003, the Douglas County distinct population segment of the Columbian white-tailed deer (distinguished in the 1983 revision to the recovery plan) was delisted due to recovery. Prior to listing, the species had declined by 1970 to just two known populations representing approximately 400–500 individuals. Largely as a result of conservation efforts and regulations on hunting, by 2002, the species increased to over 6,000 known individuals (68 Fed. Reg. 43651). This represents a population increase of 1,417.5% (based on a starting value of 400 known individuals). Despite this population increase, there remained only two known populations of the species at the time of delisting, and the range of the delisted population segment included only one county in Oregon. The basis for delisting the distinct population segment was the establishment of secure habitats. The recovery plan "did not define secure habitat to include only publically owned lands; rather, it provided further guidance on secure habitat by stating that local entities, including planning commissions, county parks departments, and farm bureaus could secure habitat through zoning ordinances, land-use planning, parks and greenbelts, agreements, memoranda of understanding, and other local jurisdictions" (68 Fed. Reg. 43651). They additionally encouraged conservation organizations to contribute through "easements, leases, acquisitions, donations, or trusts" (68 Fed. Reg. 43651).

- **Robbins' Cinquefoil (*Potentilla robbinsiana*) (67 Fed. Reg. 54968) -** In 2002, the Robbins' Cinquefoil was delisted due to recovery. This determination was based on the application of protective conservation actions and the addition of new viable populations. At the time of the listing in 1980, there was only one known population of the species that had been transected by development associated with the Appalachian Trail. Within that population, approximately 2,000 individual plants were known to occur. By the time the species was delisted, more than 14,000 individual plants were known to occur at two naturally occurring localities and two transplanted localities (67 Fed. Reg. 54968). This represents a known population increase of 600%. While the recovery plan initially called for four new transplant sites, it was later determined that only two of these sites needed to be viable. In response to comments received relating to the separation from the objectives outlined in the recovery plan, the USFWS iterated that "the objectives identified during the recovery planning process provide a guide for measuring the success of recovery, but are not intended to be absolute prerequisites, and should not preclude a reclassification or delisting action if such action is otherwise warranted" (67 Fed. Reg. 54972).

- **Aleutian Canada goose (*Branta canadensis leucopareia*) (66 Fed. Reg. 15643) -** In 2001, the Aleutian Canada goose was delisted due to recovery. In 1975, 790 individuals of the species were known to exist. By 1989, the population had increased to 5,800 known individuals (an increase of 634%). As a result of that increase, the species was down-listed to threatened. In 2000, there were 36,978 known individuals (an increase of an additional 537%) and the species was delisted (66 Fed. Reg. 15643). This represents a cumulative population increase of 4,580% from the time of listing. The species was determined to be recovered due to the discovery of new localities, the introduction of captive-bred individuals that led to an expanded range, and the elimination of threats like hunting by establishing closed hunting areas.

These are just a handful of examples where species have been delisted on the basis of recovery. In these cases, the USFWS determined that the threat of extinction and decline of the species had been reversed.

In many cases, the conditions considered for recovery were different from those outlined in the initial recovery planning process as new scientific information became available. In all cases, some forms of perpetual protective measures were implemented in support of continued species security.

As described in detail in Section 5.2.4 of this petition and consistent with these examples, a substantial level of conservation has been achieved for *T. reyesi*. These efforts have been accomplished through the establishment of permanent preserves dedicated to the protection and management of the species and more generally through the implementation of local and state regulations that minimize adverse effects on *T. reyesi* habitat across the range of the species. When coupled with the knowledge of a significantly expanded range and known distribution of the species and evidence that the threats to the species may not be as severe as originally assumed, these conservation measures sufficiently assure the continued survival of the species and avert the risk of extinction in the foreseeable future.

4.2 EXTINCTION

To date, 10 species have been delisting under the ESA due to extinction. While this is a warranted justification for the removal of a species from the protections of the ESA, it is not relevant to the *T. reyesi* and therefore not discussed further in this petition.

4.3 ORIGINAL DATA IN ERROR

The third acceptable criteria for delisting are instances where the original data used to support the listing is determined to be in error. In such cases, **delisting may be warranted if the analysis of new information or a reanalysis of the original information indicate that the existence or magnitude of threats to the species, or both, do not support a conclusion that the species is at risk of extinction now or in the foreseeable future**. Examples of species that have been delisted on the basis of an erroneous listing include:

- **Pine Barrens treefrog *(Hyla andersonii)* (48 Fed. Reg. 52740) -** In 1983, the Florida population of the Pine Barrens treefrog was delisted due to a finding that the original data were in error. The USFWS stated "recent evidence indicates that the species is much more widely distributed than originally known" (48 Fed. Reg. 52740). At the time of the listing, there were only seven known localities of this species in Florida and the predominant threat was cited as "the present or threatened modification, or curtailment of its habitat or range" (48 Fed. Reg. 52741). By 1979, several more populations were identified, and by 1980 there were over 150 confirmed occupied locations for the species (an increase of at least 2,042%). The final rule noted that while the overall distribution of the species was relatively limited, the likelihood of discovering more known localities in consideration with the additional new sites discovered indicated that "the Florida population is relatively secure for the immediate future" (48 Fed. Reg. 52741).

- **Rydberg Milk-Vetch (*Astragalus perianus)* (54 Fed. Reg. 37911) -** In 1989, the Rydberg Milk-Vetch was delisted on the basis of erroneous data. At the time when this species was listed, there was only one known locality. The subsequent delisting was based on the discovery of 11 additional localities over nine years of research (an increase of 1,100%). This delisting was supported by the existence of regulatory mechanisms that minimized the impacts of the threats identified in the initial listing factors.

- **McKittrick pennyroyal *(Hedeoma apiculatum)* (58 Fed. Reg. 49244)** - In 1993, the McKittrick pennyroyal was delisted because of "the number of newly discovered populations and the remote and inaccessible nature of the habitat" (58 Fed. Reg. 49244). This species was at the time of listing and continues to be only known from two counties, one each in Texas and New Mexico. At the time of listing, there were 7 known localities of the species. At the time of delisting, there

were 36 known populations of the species (an increase of 414%) (58 Fed. Reg. 49245). The USFWS determined that since this plant species occurs in hard-to-reach habitats, it is likely that its distribution is even broader than the confirmed locations, and that its natural preferred habitat limits the likelihood of human-related impacts.

- **Utah (Desert) Valvata snail *(Valvata utahensis)* (75 Fed. Reg 52272) –** In 2010, the Utah Valvata snail was delisted on the basis of new information. At the time of listing in 1992, the species was believed to occur in only "a few springs and mainstream Snake River sites" at, isolated points along the Snake River. The species was delisted after data showed that the species range extended an additional 122 miles beyond the initially identified range (an increase in the known range of 118.5%). The USFWS determined that due to the increased range of the species, the listing factors would not contribute to the likelihood of the species being threatened with extinction in the foreseeable future. Among the threats discussed, impacts to its habitat from agricultural and industrial purposes were excluded as threats because "the species persists in these varied mainstem Snake River systems, including impounded reservoir habitats" (75 Fed. Reg. 52280). **This distinction is critical because despite the continued presence of previously perceived threats, the proven ability of the species to continue to thrive in those conditions supported delisting.**

Since listing in 1998, a significant amount of new scientific and commercial information has become available that demonstrates *T. reyesi* occurs in significantly more locations than originally believed. Given the vastly increased number of known localities occupied by the species, many of which are protected, the perceived threats believed to apply to the species are not of a magnitude or intensity that is likely to cause the extinction of the species now or in the foreseeable future. The circumstances of *T. reyesi* are similar to those in the examples above, where the consideration of new populations or occupied sites prompted the USFWS to delist. Like the Utah Valvata snail, *T. reyesi* has also demonstrated the ability to persist and thrive in conditions where the USFWS assessment of threats should indicate a decline or extirpation (*see* section 5.2.1 for examples). This new information supports the conclusion that the protections of the ESA are no longer warranted for *T. reyesi* since the existence or magnitude of threats to the species, or both, do not support a conclusion that the species is at risk of extinction now or in the foreseeable future.

5.0 JUSTIFICATION FOR THE PETITIONED ACTION

Herein, the Petitioners present and analyze the credible scientific or commercial information that would lead a scientifically accurate species status review to conclude that delisting of *T. reyesi* may be warranted. The following assessment shows that *T. reyesi* is not at risk of extinction in the foreseeable future and therefore should be delisted.

5.1 DISTRIBUTION AND RANGE

The known distribution and range of *T. reyesi* has increased substantially since the time of the 1988 listing. At the time of listing, *T. reddelli* was known to occur in five or six caves (Tooth Cave, Bee Creek Cave, McDonald Cave, Weldon Cave, Bone Cave, and possibly Root Cave; of these, all but Bee Creek Cave were later confirmed to contain *T. reyesi*) with a range that included approximately 75 square miles (21–31 linear miles). By the release of the 1994 Recovery Plan, the USFWS recognized 60 caves with confirmed occupancy by *T. reyesi*, and nine additional caves believed to be occupied by *T. reyesi* pending taxonomic confirmation. These caves represented a range of 135 square miles, an increase of 60 square miles. By 2009 when the Five-Year Review was completed, the USFWS recognized 168 known localities for *T. reyesi* with an approximate range of 190 square miles (Figure 1).

One cave, the Barker Ranch Cave No. 1 has been identified by the USFWS as being occupied with *T. reyesi*. However, for the purpose of this petition and the scientific record for the species, this cave should not be considered a *T. reyesi* site location. Given the distribution of other occupied *T. reyesi* caves, Barker Ranch Cave No. 1 is a clear outlier, being found 16.5 miles farther south than any other known occupied cave. Further, and most importantly, the specimen was likely misidentified. The identification was based on the collection of a single juvenile specimen collected in 2000 (Ubick and Briggs 2004:108). Ubick and Briggs specifically state in their report that records of females and juveniles are only tentatively identified to species. Without DNA verification, which Ubick and Briggs did not perform, it is not possible to determine that a juvenile specimen is in fact *T. reyesi*. Given these factors, it is extremely unlikely that this specimen is *T. reyesi.* It is more likely that this juvenile belongs to the species *Texella mulaiki* which Ubick and Briggs identify as being the predominate species in southern Travis County in the vicinity where this juvenile specimen was collected. While further investigation is certainly warranted at this site, the Barker Ranch Cave No. 1 record for *T. reyesi* should be considered in error and is excluded from the analysis of the species' current status in this petition.

Nevertheless, the current body of scientific and commercial information indicates that *T. reyesi* is widely distributed across a range that is now known to encompass approximately 148 square miles, 5 KFRs, and at least 172 known localities (167 confirmed in the Five-Year Review, excluding Barker Ranch Cave No. 1, and including an additional five sites verified by ZARA in 2010). Therefore, the known distribution of *T. reyesi* (as measured by the number of known occupied localities) has expanded by approximately 3,340% over a period of 25 years. The discovery of new localities has occurred at an average rate of approximately 7.59 new sites per year (based on 167 new localities discovered between 1988 and 2010). This increase in range and known localities is depicted in Table 2 and Figure 1.

Table 2. *T. reyesi* Known Localities and Range Over Time.

Year and Source Document	Known Occupied Caves	Known *T. reyesi* Range
1988 (Final Rule)	5-6	75 square miles
1994 (1994 Recovery Plan)	60-69	135 square miles
2009 (Five-Year Review)	168	190 square miles
2014 (Delisting Petition)	172	148 square miles

Appendix C includes a comprehensive list of known occupied caves with *T. reyesi* as of the 2009 Five-Year Review or that have been subsequently confirmed to contain the species. Most of these currently known localities are shown in Figure 1. However, the precise locations of some occupied localities are no longer known or are not publicly available and are either not included on Figure 1 or are shown as only approximate locations.

This increase in known distribution clearly represents an expansion of our understanding of the species range rather than a true expansion of the *T. reyesi* population. Consequently, we now know that the analysis of threats in the 1988 final listing rule was based on extremely limited information that was premised on an erroneous understanding of the species' range as being restricted to no more than five or six locations distributed across approximately 75 square miles along the edge of the Edwards Plateau (the only known occurrences of the species at that time, one of which was actually *T. reddelli*).

The significant increase in known localities of *T. reyesi* is a consequence of increased survey effort over areas of potential habitat. The full extent of potential habitat for *T. reyesi* where the species has a possibility for occurrence may be approximated by the area of Karst Zones 1 and 2 delineated by Veni (1992, as updated in 2007). These karst zones encompass approximately 125 square miles across the

known range of the species and it is extremely likely that within this area, more caves will be discovered. Further, this area supports extensive mesocavernous space (interstitial space) likely occupied by the species in areas not accessible to biologists. The USFWS provided a 100-acre buffer around occupied caves in the critical habitat designation for karst invertebrates in Bexar County to account for “subsurface karst deposits, the cave footprint, surface and subsurface drainage areas, a cave cricket foraging area, and, where possible, at least 100 acres (40 ha) of undisturbed or restorable vegetation” (77 Fed. Reg. 8461). This represents an area designed to include mesocavernous space under the ground that is not included in the cave footprint itself and therefore, should be included in calculations of available habitat. Given the use of mesocavernous space in regulatory considerations, these areas must be considered in the evaluation of occupied habitat.

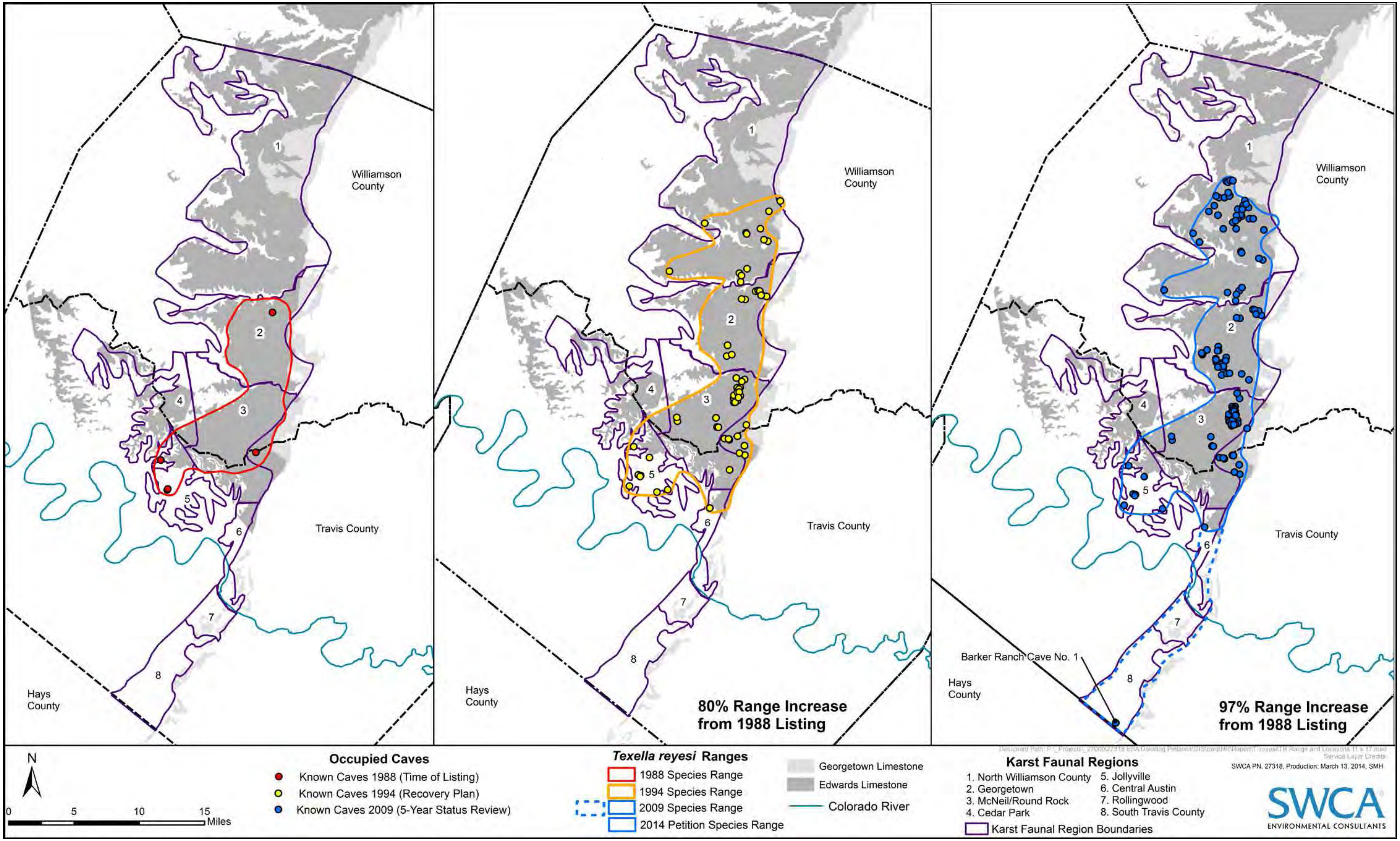

Figure 1. *T. reyesi* known localities and distribution over time.

Therefore, a review of the best available scientific and commercial data indicates that *T. reyesi* is not restricted to a small number of isolated caves as purported in the 1988 listing rule, but is instead a relatively wide-ranging occupant of karst habitats across at least 148 square miles of Travis and Williamson counties. The species has been and continues to be found in new locations across areas of potential habitat as more survey work is conducted, both within known caves subject to additional survey effort and within newly discovered caves across its range. While much of this distribution and range information is acknowledged by the USFWS in various publications, the USFWS has failed to quantify and address the implications of this increasing body of information in any status review completed subsequent to the final listing rule. The heavy reliance of the USFWS on this "extremely limited" range and distribution to justify the final listing rule substitutes surmise and opinion for scientific data.

The Petitioners believe that the new distribution and range information available since the time of listing warrants a complete reevaluation of the relevance of the listing factors and the magnitude of the threats to the species to reach an appropriately informed decision about whether or not the continued protection of the ESA is necessary to prevent the extinction of *T. reyesi*.

5.2 ANALYSIS OF LISTING FACTORS

As previously discussed, known populations of *T. reyesi* have increased from five confirmed locations to at least 172 known locations—an increase of 3,340 percent. This increase in known population is comparable in extent to delisting examples described earlier for several other species. However, when conducting the 2009 Five-Year Review of *T. reyesi*, the USFWS completely failed to evaluate these new scientific and commercial data in light of the listing factors.

Analysis Framework and Examples

The ESA does not identify a minimum population or range size that must be achieved and maintained to warrant delisting. A listing or delisting determination is to be based entirely on the risk of species extinction from any one or a combination of the five factors provided in the ESA. This distinction is critical because even in cases where there is only one known locality for a given species, if that locality is not subject to any of the five listing factors, listing under the ESA is not warranted. For example, in 2005, the USFWS made the determination not to list the greater and lesser Adams cave beetles (*Pseudanopthalus cataryctos)* after a Candidate Conservation Agreement with Assurances (CCAA) (TE-088168-0) was approved by the USFWS that effectively eliminated all concerns that may have been realized pursuant with the listing factors. This determination was made despite the two beetles only having one known locality and the CCAA only including 1 acre of land.

The CCAA, approved by USFWS, states that "contributions to this CCAA are expected to alleviate these threats by controlling the identifiable, potential sources of those threats" (Southern Conservation Corp. 2005:3). The USFWS determined that "these conservation efforts will reduce or eliminate the threats to the survival of the two beetle species, precluding the need for listing them under the ESA" (MacKenzie 2005). In this case, the USFWS determined that because the species were protected under a conservation agreement, none of the listing factors were considered likely to result in extinction for the species in the foreseeable future despite there being only one known occurrence of the two species. This example shows how species that do not meet any of the listing factors must be delisted regardless of the known range of the species.

In 2006, the USFWS made the controversial decision not to list the Cerulean warbler. While conservation groups lead by the Southern Environmental Law Center and the National Audubon Society cited concerns that habitat had been lost and modified enough to warrant listing, the USFWS ultimately determined that listing was not necessary because "the species is unlikely to be in danger of extinction in the foreseeable future" (Parham 2006). This determination acknowledged that the population of the species is declining,

however similarly determined that the rate of decline was slow enough that the species population would ultimately “number in the tens of thousands 100 years [from the time of the ruling]” (Parham 2006).

The example of the Cerulean warbler and others enforces the application of the definitions and terms outlined in the ESA. “It is the Act's definitions of endangered (i.e., “in danger of extinction throughout all or a significant portion of its range”) and threatened (i.e. “likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range”) that provide the applicable standards for determining whether a species has “recovered” (Goble 2010:72). Critical to note is that the Cerulean warbler was shown to be declining but deemed not warranted for listing. In contrast, the known localities for *T. reyesi* have increased substantially without any indication of species decline, which should similarly support a determination that the protections of the ESA are not warranted. If the listing factors do not indicate that a species is likely to be threatened with extinction in the foreseeable future, the species should not be listed.

Listing Factor Analysis

Since the Five-Year Review failed to adequately address the listing factors, the Petitioners provide the following analysis of the listing factors as they apply to the *T. reyesi* based on the best currently available scientific and commercial data. This analysis conclusively shows that the listing factors when discussed in the specific context of *T. reyesi* do not warrant the continued listing of the species. Previous actions by the USFWS, such as the decisions not to list the Adams Cave beetle and Cerulean warbler, support the petitioned action as consistent with the application of the ESA and similar consideration should be afforded *T. reyesi.*

5.2.1 Listing Factor A: The present or threatened destruction, modification, or curtailment of habitat or range

The 1988 Final Rule states that “the primary threat to the five species comes from potential loss of habitat owning to ongoing development activities” (53 Fed. Reg. 36031). In listing this threat, the final rule provides no evidence supporting this claim. While there has been minimal scientific research on the actual impacts of development on cave habitats, there are many examples where *T. reyesi* has continued to persist alongside development activities. There is no evidence that development activities have led to a significant reduction in the population size or distribution of *T. reyesi* across all or a significant portion of its range. In fact, despite development, the number of known localities of the species has steadily increased since listing. This refutes the USFWS assertion that development, particularly given the number and distribution of currently protected *T. reyesi* localities, is a threat to the continued existence of the species.

There are at least five well-studied examples of occupied caves that have remained occupied despite occurring near areas with typical development. The caves include Inner Space Caverns, Sun City (multiple caves), Weldon Cave, Three-Mile Cave, and Four-Mile Cave. In these instances, biologists have observed that development has not resulted in a decrease in *T. reyesi* abundance, and in some instances, it appears that human activities may have had a positive impact on population numbers. At the very least, these examples show that in lieu of peer-reviewed scientific studies demonstrating significant negative effects of development on cave habitats and occupancy by *T. reyesi*, there is ample documentation that the extreme caution recommended by the USWFS is not warranted. It is critical to note that these examples represent only a few of the known caves that occur in and around developed areas and support the ability of *T. reyesi* to persist despite proximity to these activities.

- *Inner Space Caverns:* Inner Space Caverns in Williamson County was discovered in 1963 during construction of Interstate 35 when a core drilling team for the Texas Highway Department drilled

through 40-feet of limestone to discover the cave. In 1966 the cave was opened to visitors and currently receives approximately 100,000 visitors annually for guided tours throughout various reaches of the cave. The cave has been equipped with walkways, electrical lighting, and other conveniences for visitors.

In 2007, biologists surveyed the cave for troglobitic species (SWCA 2007, unpublished data). From previous surveys (Reddell and Finch 1963, Elliott and Reddell 1989 and 1991, Chandler 1992, Gertsch 1992, Ubick and Briggs 1992) it was known that at least ten troglobites were found in the cave, including *T. reyesi*. Given the assumptions identified by the USFWS in its final rule, the discovery, modification, and commercialization of Inner Space Caverns should have resulted in the extirpation of *T. reyesi* from this location. Contrarily, surveys conducted in 2007 showed a continued presence of *T. reyesi* at the site and SWCA Environmental Consultants (SWCA) biologists noted that the species appeared to be more abundant in the "developed" parts of the caves where there has been artificial lighting, walkways, and a constant flow of tourist traffic for more than forty years.

While no formal survey effort has occurred at Inner Space since 2007, SWCA-permitted biologists have observed *T. reyesi* occupying a light fixture control box in the cave during every visit these biologists have made to the cave (at least annually), with the most recent observation occurring in the spring of 2013 (Dr. Kemble White, personal communication 2014). **Therefore, there is no evidence that 40 years of access to, and modification of, the cave environment presents a direct threat to the species in the cave.**

While the Petitioners do not intend to imply that all caves should be developed and/or used for commercial activities, it should be acknowledged that human presence in and around a cave alone does not necessarily result in discernible threats to the species. Inner Space Caverns provides a strong example since this cave has experienced extensive development—it is located under a road, under train tracks, the inside of the cave has been paved, it receives significant human visitation, it has electrical lines that have been installed throughout to power lights, etc., and biologists continue to identify *T. reyesi* on every visit to the cave.

- *Sun City:* In 1995, development began on a residential subdivision known as Sun City, Texas. Development activities at Sun City were expected to last for twenty years and include 5,600 acres. The development is currently on-schedule with its construction goals. The Sun City property includes 95 caves, of which 26 are known to contain federally listed species. All of the caves on the property have been inspected for karst fauna. *T. reyesi* occurs in at least 25 of these caves. In 1995, the USFWS approved a management plan for a complex preserve system on the property that includes regular management, monitoring, and biological inspections. No Incidental Take Permit was provided by the USFWS for the development. Rather, the preserve management system supported the use of an avoidance plan that facilitated a no-take determination from the USFWS. Eleven caves have been monitored regularly since 1995 and data through 2000 are currently available to the Petitioners. In 2000, after five years of development activity, an additional survey of all the caves was conducted.

  Interestingly, the 2000 survey found that one cave located in the center of the golf course with extensive development all around (Kiva Cave No. 1) showed a "slight (but probably not statistically significant) increase in fauna" and has consistently been the most dependable cave for *T. reyesi* surveys (Reddell 2000:3; Dr. Kemble White, personal communication 2014). Another cave in a developed area (Holler Hole Cave) showed some minor signs of decline that were attributed to a prolonged period of drought and the presence of Ashe juniper above the cave. The remaining caves are outside of the developed areas of the property, and have shown variability in the amount of fauna detected throughout the years of monitoring. Ultimately, monitoring reports

indicate that there has not been any substantial negative change in the populations of cave fauna across the entire property since the monitoring began, despite an increase in nearby development activities. "The conclusion to be drawn from these studies is that the fauna of the caves has not been adversely affected by construction or other activities on Sun City. Biodiversity in many cases has increased and in none is there any indication that is has decreased" (Reddell 2000:4). This clearly supports the no-take determination made by the USFWS prior to the project beginning.

Looking toward the future, Reddell additionally determined that "there is no reason to believe that development of Sun City will lead to harm to the cave fauna" (Reddell 2000:4). While more recent survey data is not publically available, biologists working in Sun City continue to regularly observe *T. reyesi* during annual surveys on the property (Dr. Kemble White, personal communication 2014).

- *Weldon Cave:* At the time of the 1988 listing, concern was expressed over Weldon Cave, a known occupied cave for *T. reddelli* (and later identified as a *T. reyesi* occupied site), that due to a recent road extension and neighboring residential development, the cave "may no longer exist" (53 Fed. Reg. 36031). Despite these identified threats in 1988, in 2009 when developing the Five-Year Review, USFWS identified Weldon Cave as a high potential KFA site. This was the only example of potential development related impacts to the *T. reddelli* presented in the final rule and after 25 years, these threats have not been realized and Weldon Cave remains a viable cave for the species. This cave alone provides ample evidence that the threats leading to listing were seriously overstated at the time.

- *Three-Mile Cave and Four-Mile Cave:* Both of these caves are located under State Highway 29 west of Georgetown in Williamson County, and both were confirmed as occupied by *T. reyesi* through survey efforts conducted by SWCA in 2008 and 2009 respectively. The entrances to both of these caves are in close proximity to the highway, and the features themselves extend below the highway in both cases. Four-Mile Cave was inaccessible prior to 2009 survey efforts as the entrance had been blocked off with large boulders, likely to deter vandalism and trespassing. The interior walls of the cave have been covered in historic graffiti (estimated to be from the 1890s, 1920s, and 1950s) showing that prior to the entrance being blocked off it was frequented by human visitors. Despite this confirmed historical use and close proximity to the five-lane highway (the entrance is within the drainage ditch of the east bound lanes of the highway), the cave remains occupied by *T. reyesi* (Dr. Kemble White, personal communication 2014).

The initial determination provided in the 1988 final rule for the species provided an extremely limited and unsupported case for the impacts caused by development. The one example that was provided in 1988 has been disproven. If one considers the current evidence regarding this listing factor, there are several examples that show the species' ability to coexist with development. The 26 years since the initial listing have offered several opportunities for there to be quantifiable evidence to show the impacts of development, and no strong negative correlations have been confirmed. Examples like Inner Space Caverns, Sun City, and Weldon Cave are only a few showing that impacts of development are likely not as significant to the species as was anticipated in the 1988 final rule.

The lack of legitimate threats is further supported by the use of mesocavernous space by the species. *T. reyesi* is consistently found in the dark parts of caves. According to Ubick and Briggs (1992:211), "in all instances they have been found only in the more remote parts of the caves, [and] none have been found in twilight, with the exception of the single juvenile from Comanche Trail Cave." This supports the results of surveys conducted in Sun City that have shown that the species seems likely to retreat deeper into caves under dry surface conditions such as the presence of drought and excessive drying vegetation (like juniper). It is likely that this behavior has limited the amount of available scientific data on the species as

much of the available *T. reyesi* habitat is not accessible to biologists. While *T. reyesi* has been documented as occurring at 172 localities, the true extent of the habitat for this species is likely to include much of the 125 square miles of Karst Zones 1 and 2 mapped within the range of the species.

This use of mesocavernous spaces by karst invertebrates was not considered at the time of the 1988 listing. At that time, it was believed that each of the species listed occurred in “small, shallow, dry caves” (53 Fed. Reg. 36029). The final rule additionally described the occupied caves as “isolated islands” indicating that they were “separated from one another when stream channels cut through the overlying limestone to lower rock layers” (53 Fed. Reg. 36030). While this continues to be a growing area of study, there is evidence that supports the characterization of mesocavernous spaces as occupied habitat. This concept is supported in the Five-Year Review by the USFWS claim that “troglobitic habitat includes caves and mesocavernous voids in karst limestone (USFWS 2009:2).

Monitoring activities on the Sun City Preserve have “demonstrated that opening of previously filled caves leads to an increase in population size for troglobitic species” (Reddell 2000:4). Monitoring activities also indicate that at any given cave, *T. reyesi* may not always be identified during a survey. Sun City surveys indicated that in some cases, “one or more species may be extremely abundant on one date but rare or absent on another. At the same time, other species on the same dates may be rare or absent.” (Reddell 2000:4). With this in mind, it is critical to note that simply because one survey does not produce any specimens of *T. reyesi*, a negative survey result does not preclude that cave from being occupied habitat. Research at Sun City found that it was less likely that *T. reyesi* would be detected in caves during dry seasons or periods of drought. Reddell posits that *T. reyesi* retreats deeper into the caves and/or utilizes the mesocavernous spaces where the habitat maintains more moisture. This trait not only complicates routine surveys for the species, but mitigates many potential threats to the species since they are able to retreat to other habitats as climactic and surface conditions warrant.

USFWS karst invertebrate collection protocols were developed specifically with this behavior in mind. According to existing karst invertebrate survey requirements, “notable differences in species abundance have been observed within as little as a week within caves that cannot be accounted for by rainfall or other surface condition” (USFWS 2011:11). For this reason, survey protocols include multiple survey efforts (a minimum of 3 as of 2011) to determine presence/absence.

The documented use of mesocavernous space by *T. reyesi* is significant because the full range and extent of these underground habitats cannot be fully known by scientists. Further, these areas are significant in relation to species survival because they are geologically protected from development and other activities that may occur on the surface or near the humanly accessible openings of occupied caves. Given the approximately 125 square miles of potential underground mesocavernous space within Zones 1 and 2 of the species' range, it is extremely likely the species is able to retreat into these mesocavernous spaces to avoid unfavorable conditions and continue to thrive (Veni and Associates 1992; USFWS 2009). This is further supported by the presence of *T. reyesi* in caves that were previously unoccupied or sealed (for example, caves previously discussed in Sun City).

5.2.2 Listing Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

Overutilization was not considered a significant threat at the time of listing and there is no evidence that a current threat of this sort exists. Rather, the continued presence of the species in well-documented caves (such as Inner Space Caverns which is subject to extensive use for commercial purposes with an arguably positive benefit to the species) supports the premise that overutilization is not a current or potential threat to the species.

5.2.3 Listing Factor C: Disease or predation

In Texas, no endangered species have been known to become extinct because of red imported fire ants (RIFA) (Drees 2002). Without significant evidence, RIFA have been generally considered a major threat to endangered karst invertebrates in Bexar, Travis, and Williamson counties. Long-term impacts of RIFA on karst invertebrates or their habitat have never been quantified or scientifically tested, instead, they have simply been assumed to have a major impact. The literature related to the interaction of RIFA and karst invertebrates is based solely on anecdotal evidence, professional opinion, unpublished technical reports, and other non-peer-reviewed literature of questionable reproducibility.

Short-term impacts on RIFA on some invertebrate communities have however been reported. In response to the delisting petition in 1993, the USFWS cited a 1990 study showing the disruption of above ground arthropod communities by RIFA that was conducted during the initial invasion of RIFA in Travis County, Texas by Porter and Savignano. Porter and Savignano (1990) demonstrated that RIFA dramatically reduce arthropod abundance and species richness soon after infestation of RIFA to an area. They found that native ant species richness was 70 percent less in infested areas and overall arthropod species richness was 40 percent less in infested areas than un-infested areas. While the results of this study would seem to indicate that RIFA do have a negative impact on the species, a subsequent study by Morrison in 2002 revisited the Porter and Savignano (1990) study area 12 years later and replicated their study. Morrison (2002) found that arthropod communities had rebounded to pre-RIFA-invasion levels and that all measures of native ant and other arthropod species' diversity had returned to pre-invasion levels. RIFA were still the most abundance ant species, but not nearly as abundant as during the initial RIFA infestation. He concluded that the impacts to arthropod communities by RIFA might be greatest during and shortly after the initial RIFA invasion but long-term impacts are likely not as significant as once believed. This subsequent study is not acknowledged by the USFWS in any of their evaluation of the status of *T. reyesi*, but represents new scientific information, including refutation of previous conclusions regarding the susceptibility of *T. reyesi* to RIFA infestations.

RIFA have been in found in parts of Bexar and Bell counties since about 1960, Comal County since about 1976, and Travis, Williamson, and Hays counties since about 1980. All of these counties contain caves with karst invertebrate species. No doubt RIFA, along with other native species occasionally forage on *Ceuthophilus* cave crickets, and on rare occasions, karst invertebrates. Despite this, as previously discussed, Morrison found that surface arthropods communities in Travis County are able to successfully rebound after the initial infestation. Moreover, after approximately 45 years of infestation of RIFA in Bexar County, karst invertebrates are still present in Bexar County karst preserves.

A biological study of karst features on Sun City, Texas in 2000 conducted by James Reddell observed that RIFA had invaded every cave on the property, however Reddell determined that “no direct predation has been observed on either *T. reyesi* or the Coffin Cave mold beetle (*Batrisoides texanus*), but ants have been observed feeding on cave cricket nymphs and both species of troglobitic millipede” (Reddell 2000:8). Despite RIFA being present, there has not been a decline in the known populations of *T. reyesi* on the property.

In 2006, SWCA conducted an investigation in an attempt to describe cave cricket, RIFA, and other species interactions at potential food sources around caves within six of the seven La Cantera preserves. This was based on the assumption that even if RIFA do not actively feed on the troglobitic *Cicurina* species in Bexar County, they may still be threatened through competition created between RIFA and the cricket food source. To conduct this study, freeze-killed crickets (*Acheta domestica*), Texas persimmon (*Diospyros texana*) fruit, store-bought spinach, native organic matter, and water bait stations were used to observe forage preferences of cave crickets and other species.

Arthropods observed foraging around cave entrances at bait stations are listed from most common to least common and included big-headed ants (*Pheidole dentata*), carpenter ants (*Camponotus castaneus*) (ant identification confirmed by Texas A&M), cave crickets (*Ceuthophilus* spp. mostly *secretus*), daddy long-legs (*Leiobunum townsendii*), RIFA, and various beetle species. Freeze-killed crickets were favored by big-headed ants, carpenter ants, daddy long-legs, cave crickets, and RIFA. Texas persimmon fruit was the next most favored food item and was primarily favored by big-headed ants, carpenter ants, cave crickets, and various beetles. Big-headed ants were usually the first to arrive at bait stations.

At bait stations, competition between cave crickets and daddy long-legs was sometimes observed, especially when daddy long-legs emerged first from a cave and "beat" cave crickets to bait stations. Competition was also observed between big-headed ants and carpenter ants. No major competition between RIFA and other arthropods was observed; though, this was likely due to low RIFA numbers and would have very likely been observed if RIFA numbers were higher. Interestingly, RIFA were only observed at freeze-killed cricket bait stations on the largest 75-acre preserve; though, RIFA were outnumbered by big-headed ants.

Competition was commonly observed between native big-headed ants and cave crickets. If freeze-killed crickets were placed at stations too early in the evening before the cave cricket emergence, big-headed ants would remove all of the freeze-killed crickets and leave nothing for cave crickets or other animals. If no big-headed ants were foraging at freeze-killed cricket bait stations, cave crickets would "casually" graze at the stations. When big-headed ants arrived at bait stations occupied by cave crickets, cave crickets would be "chased off". If the cave cricket was large enough, it would often leave with a freeze-killed cricket in its mandibles when it was chased off. When big-headed ants were occupying freeze-killed cricket bait stations before cave crickets (as was the case most of the time), larger cave crickets would sometimes jump in and "steal" a freeze-killed cricket (sometimes unsuccessful) and immediately jump away from the big-headed ant infested bait station. Smaller cave crickets, though often attempted to grab a freeze-killed cricket, were often not large enough to grab a freeze-killed cricket and were "chased off" by big-headed ants. What these observations indicate is 1) many organisms, including native species, compete with cave crickets, 2) cave crickets can cope with competition by leaving with or "stealing" food items from competitors, and 3) availability of food sources for cave crickets, such as dead and dying arthropods and other high protein food sources, is dependent on the availability of food sources at the time of the cave cricket emergence—food items available too early may be foraged upon by diurnal or crepuscular species and not available for cave crickets.

In San Antonio, SWCA has been actively managing the La Cantera cave preserves since their protection in 2001. One management objective has involved regular monitoring of RIFA and bi-annual biological surveys of cave fauna at each cave on the preserve. For the 2012 La Cantera Preserve Annual Report (submitted to the USFWS), SWCA (2013) conducted an evaluation of over ten years of collected scientific data, not finding any correlation between the rate of occurrence of RIFA and the populations of cave crickets or federally listed *Cicurina* spiders identified during surveys, refuting arguments that RIFA is a significant threat.

In summary, predation or competition by RIFA has not been shown to have a lasting negative impact on populations of *T. reyesi* or the ability of the species to persist in areas that also contain RIFA. Therefore, this purported threat is not of significant magnitude to push the species towards extinction in the foreseeable future.

5.2.4 Listing Factor D: The inadequacy of existing regulatory mechanisms

In 2003, the USFWS published in the Federal Register its final Policy for Evaluation of Conservation Efforts When Making Listing Decisions, the "PECE Policy" (68 Fed. Reg. 15100, March 28, 2003). The PECE Policy is the USFWS guide on how to evaluate formalized conservation efforts (e.g., conservation

agreements, conservation plans, management plans, and similar documents approved by Federal agencies, state and local agencies, businesses, organizations, or individuals) when deciding whether or not to list a species. As defined by the PECE Policy, "conservation efforts" are "specific actions, activities, or programs designed to eliminate or reduce threats or otherwise improve the status of a species. [They] may involve restoration, enhancement, maintenance, or protection of habitat; reduction of mortality or injury, or other beneficial actions" (68 Fed. Reg. 15113).

Existing Preserves and Protected Habitats

A desktop review of existing public and private preserve lands, lands protected via Section 10 and Section 7 consultations, and other relevant land management activities identified approximately 94 occupied caves for the *T. reyesi* that are currently under some form of protection from land development and/or receive regular management. This represents more than one-half of all known occupied localities of the species recognized by the USFWS, and includes protected caves throughout the entire known range of the species. Among these protected caves are three additional KFAs recognized and approved by the USFWS since the Five-Year Review of *T. reyesi*. The four currently recognized KFAs that fully protect *T. reyesi* are the Twin Springs Preserve, Cobbs Cavern Preserve, Priscilla' s Well Preserve, and Karankawa KFA.

In addition to the four accepted KFAs, there are 28 de facto KFAs acknowledged by the USFWS in the Five-Year Review. These caves have the potential to meet the minimum geographic requirements for a KFA but may not have the required management structure. Some meet both criteria but have yet to be formally accepted as KFAs.

- Polaris Cave
- Shaman Cave
- Pow Wow Cave
- Red Crevice Cave
- Temples of Thor Cave
- Thor Cave
- Jensen Cave
- Lobo' s Lair
- Wolf' s Rattlesnake Cave
- Round Rock Breathing Cave
- Steam Cave
- Fence-line Sink
- Blessed Virgin Cave
- Raccoon Lounge Cave
- WS-54
- WS-71a
- WS-65310
- Chaos Cave
- Rockfall Cave
- Weldon Cave
- Gallifer Cave
- Tooth Cave
- McDonald Cave
- Stovepipe Cave
- MWA Cave
- Eluvial Cave
- Jollyville Plateau Cave
- Beard Ranch Cave

The significant number of permanently protected *T. reyesi* localities indicates that the species is not likely to return to a vulnerable status following delisting.

The current KFAs have been recognized through regulatory action by the USFWS. For example, in the 2011 Biological Opinion for State Highway 195 in Williamson County (Consultation No. 21450-2006-F-0132) incidental take of six *T. reyesi* occupied caves was authorized following the determination that no jeopardy of the species would occur. This decision depended upon the existence of previously preserved caves, specifically within the North Williamson County KFR. The USFWS determined that "if Cobbs Cavern is purchased and preserved, there will be three KFAs within this KFR, meeting recovery criterion 1 for this species" (Mowad 2011). At the time, the acquisition of Cobbs Cavern was underway and has since been finalized. This conclusion by the USFWS confirms that the presence of preserved areas eliminates the threat of jeopardy to the species.

Including the approved KFAs and the recognized de facto KFAs, there are at least 94 occupied caves spanning the entire range of the species that are currently afforded protection. It is likely that more known localities are protected through efforts not identified in the initial desktop review. Caves identified during the desktop review with protections and management activities are indicated in Figure 2 and described in Appendix A. These are not exhaustive lists, as more caves with undisclosed locations and management activities likely exist across the region.

City of Austin Regulations

The City of Austin has in place regulatory programs/mechanisms for protection of water quality, recharge features, and karst areas which have the benefit of providing protection of suitable habitat for karst invertebrates, including *T. reyesi*. These protections cover approximately 63,344 acres (approximately 67 percent) of currently known *T. reyesi* range.

Pursuant with Section 1.3.0 of the City of Austin Environmental Criteria Manual, an environmental assessment and City developed Critical Environmental Feature Worksheet is required any time proposed development activities occur near a karst feature. These activities require the identification of proposed protective measures for the feature, including proposed setbacks from the feature. Caves are defined by the Manual as "underground voids large enough for an adult to enter" and a standard setback of a 150- to 300-foot radius around the feature is required. Further, any activities must preserve all natural characteristics of the feature. The same regulations apply to sinkhole and recharge features.

To ensure compliance with these regulations, "all work must stop if a void in the rock substrate is discovered which is; one square foot in total area; blows air from within the substrate and/or consistently receives water during any rain event" for the completion of a geological assessment (P-1). These measures offer protection to karst features and *T. reyesi* habitat throughout the City of Austin in both known occupied and presumably unoccupied caves, and this protection will still be enforced regardless of the listing status of *T. reyesi*. The use of buffer zones protects the cave habitats from exposure to contaminants and disruption from direct development activities.

The City of Austin further expanded this ordinance in 2008 through the Void and Water Flow Mitigation Rule (adopted April 22, 2008) requiring that a licensed geologist be present at least once per day during all trenching operations and to inspect sites for sensitive features prior to any backfilling. In the event a feature is discovered, prior to any work proceeding, mitigation must be proposed and approved by the City of Austin through a permitting process. Void mitigation was adopted by the City of Austin to "preserve the hydrologic function of the void, maintain recharge paths to springs, creeks and wells, isolate the void from potential contaminants, maintain the structural integrity of the void and adjacent utilities and buildings, and to protect the Edwards Aquifer" (Pope 2009). These efforts offer protection and mitigation for all void spaces meeting the specifications and therefore afford protection to the mesocavernous spaces that may potentially be occupied by *T. reyesi* as well as open caves.

Section 1.3.4 requires that a Pollution Attenuation Plan be completed for all industrial development projects "not enclosed in building" (Section 1.3.4). The City of Austin requires the Pollution Attenuation Plan in addition to other state and federal permitting requirements (such as the TPDES permit and other related TCEQ permits). This provides an extra level of review to ensure that implemented procedures are conducted in the most environmentally sustainable way.

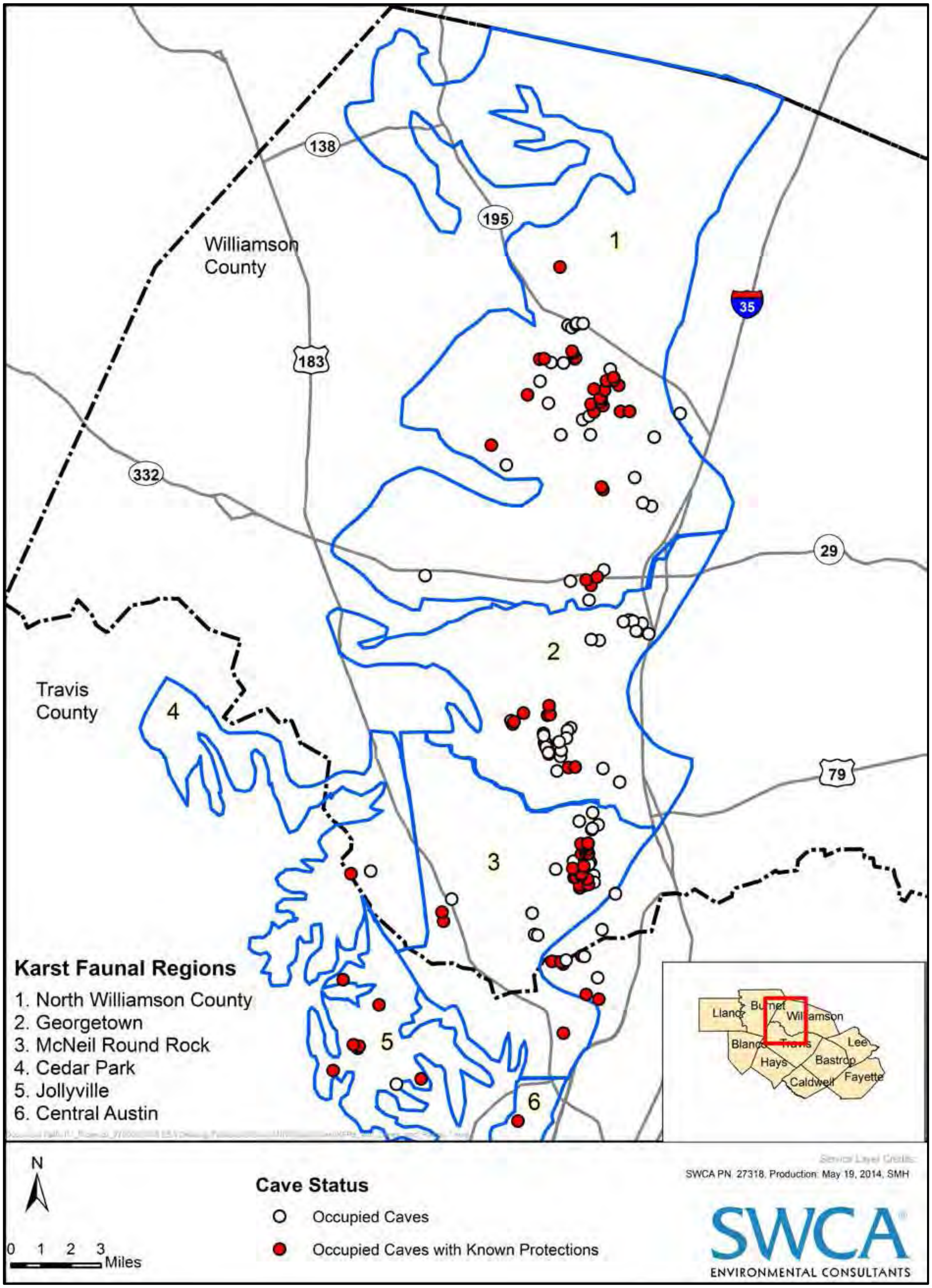

Figure 2. Occupied *T. reyesi* caves with known protection and/or management activities.

Collectively, these measures reduce potential impacts to *T. reyesi* that may arise from pollution run-off into sensitive features in and around the City of Austin. The City of Austin also has an active Stormwater Management Plan that establishes criteria for the use of best management practices (BMPs) to minimize stormwater run-off into sensitive features. These measures reduce potential impacts to *T. reyesi* that may arise from pollution run-off into sensitive features in and around the City of Austin and provide regional protection to the species that extends beyond known occupied sites.

City of Georgetown Water Quality Management Plan

On December 20, 2013, the City of Georgetown adopted Resolution No. 122013-C adopting a Water Quality Management Plan (the "Management Plan") for the City. The goal of the Management Plan is specifically to protect the Georgetown Salamander and its habitat, but the benefits will extend to *T. reyesi* through measures across the City that will improve water quality. These measures include public education, illicit discharge detection and elimination, construction site stormwater runoff control, post-construction stormwater management in new development and re-development, and pollution prevention and good housekeeping for municipal operations. This plan provides further detail on how the City will comply with its MS4 permit, thereby reducing threats from the ongoing effects of urbanization and hazardous materials spills. This program also reduces sediment discharges and water quality.

These measures, like the City of Austin regulations, encourage the use of best management practices focused on preventing harmful materials from reaching known and potential *T. reyesi* habitat. The measures of the Management Plan afford protections to approximately 10,223 acres within the known range of *T. reyesi*.

Texas Commission on Environmental Quality Regulations

The Texas Commission on Environmental Quality's (TCEQ) Edwards Aquifer Rules (the "Edwards Rules") were enacted to prevent water quality degradation within the Edwards Aquifer and, thereby, to benefit public health, aquatic and terrestrial life, and the Texas economy. The stated purpose of the Edwards Rules is:

> that the existing quality of groundwater not be degraded, consistent with the protection of public health and welfare, the propagation and protection of *terrestrial* and aquatic life, the *protection of the environment*, the operation of existing industries, and the maintenance and enhancement of the long-term health of the state.

30 TAC § 213.1(1) (emphasis added). This set of rules includes a number of specific measures that significantly reduce threats to *T. reyesi* related to urbanization and construction activities; pollution of karst habitats from pesticides, fertilizers, and hazardous materials; and physical modification of surface habitats. Since the surface-connected caves and mesocavernous spaces that provide habitat for *T. reyesi* are also considered significant recharge features to the Edwards Aquifer, the conservation measures required by the Edwards Rules also directly benefit *T. reyesi*. The Edwards Aquifer Rules were significantly modified in 1999 to increase the protections afforded through these regulations. These amended rules reflect new conservation measures that have been implemented since *T. reyesi* was listed.

Among other things, the Edwards Rules require that for any construction-related activity occurring over the Edwards Aquifer, detailed studies and reports must be made and submitted, and certain BMPs be implemented. The BMPs under the Edwards Rules are specific measures designed to prevent pollution of surface and groundwater, maintain flow to naturally-occurring sensitive features, and provide erosion and sediment control. The BMPs include measures such as storm water detention ponds, grassy swales, buffers, and setbacks. The benefits to the *T. reyesi* from implementation of the Edwards Aquifer Rules

include the development and implementation of Edwards Aquifer Protection Plans (such as water pollution prevention plans, sewage collection system plans, and underground and aboveground storage tank facility plans), wastewater treatment and disposal system permits, optional enhanced measures for water quality protection, revised BMPs for quarry operations, measures for plugging abandoned wells and borings, prohibitions on certain types of activities over the recharge zone, and Contributing Zone plans. Each program is administered and enforced by the TCEQ and includes requirements for monitoring and reporting necessary to ensure that measures are implemented as required by the rules, with schedules and defined standards for implementation.

TCEQ's Texas Pollution Discharge Elimination System (TPDES) permitting program is designed to minimize sedimentation and contamination in surface waters by regulating stormwater runoff from construction sites. TPDES is authorized by the EPA as part of its National Pollution Discharge Elimination System (NPDES) for regulating point source pollution to waters of the United States. To be covered under the TPDES Construction General Permit, anyone disturbing 1 acre or more of land or part of a larger common plan of development that will disturb 1 acre or more of land must prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) before discharging stormwater to any surface water in the State of Texas. The plan must describe the intended sequence of major activities that disturb soils for major portions of the site, estimate the total area of the site and the total area of the site that is expected to be disturbed, and describe which BMPs will be used to minimize pollution in runoff before, during, and after construction.

Development and implementation of a site-specific SWPPP minimizes the potentially adverse effects of surface runoff from construction. These plans significantly reduce the amount of sedimentation and related pollutants carried in stormwater runoff and thereby significantly reduce threats to the *T. reyesi* related to urbanization, hazardous materials spills, and construction activities. TCEQ assures the implementation and effectiveness of this program by required regular inspections for proper application of BMPs, personnel training for those working on construction sites, record keeping, and formal certification of BMPs implemented on-site.

Under the TPDES permitting program, TCEQ also administers EPA's Municipal Stormwater Program. Phase I of this program, begun in 1990, requires Municipal Separate Storm Sewer Systems (MS4s) in medium and large cities (or certain counties with populations of 100,000 or more) to obtain NPDES permit coverage for their stormwater discharges. Phase II, begun in 1999, requires regulated small MS4s in urbanized areas, as well as small MS4s outside the urbanized areas that are designated by TCEQ, to obtain NPDES permit coverage for their stormwater discharges. Each regulated MS4 is required to develop and implement a Stormwater Management Program (SWMP) to reduce the contamination of stormwater runoff and prohibit illicit discharges. Each SWMP must address six minimum control measures: public education; public involvement; illicit discharge elimination; construction sites; post construction pollution; and pollution prevention for municipal operations. The SWMP describes in detail which BMPs will be implemented to meet permit requirements.

The MS4 program reduces threats to *T. reyesi* from the ongoing effects of urbanization and hazardous materials spills by helping to ensure that stormwater runoff is relatively free from pollutants, including sediment from post-construction developments, illicit discharges of hazardous materials from individuals or businesses, and operations of municipal properties. This program also reduces physical threats to surface habitats in the form of reduced sediment discharges. The TCEQ has the authority to issue significant penalties (up to $27,500 per day) for non-compliance with MS4 permits.

Endangered Species Act

At least nine caves known to be occupied by the *T. reyesi* will continue to be afforded protections under the ESA, including all currently recognized KFAs, due to the presence of other listed species within the

same cave. In these instances, even if delisted, *T. reyesi* will benefit from the protections of the other listed species present in that locality. Caves that will continue to be afforded protection from the ESA after a delisting are included in Table 3.

Table 3. Caves Occupied by *T. reyesi* and Other Federally Listed Species

Species known to occupy along with *T. reyesi*	Occupied Caves
Tooth Cave Ground Beetle *(Rhadine persephone)*	Hide-Away Cave
	Lakeline Cave
	Raccoon Cave
	Testudo Tube Cave
Coffin Cave Mold Beetle *(Batrisodes texanus)*	Cobbs Cavern Cave
	Inner Space Caverns
	Off-Campus Cave
	On-Campus Cave
	Red Crevice Cave
	Deliverance Cave No. 2*
	Dragonfly Cave*
	Electro-Mag Cave*
	Hourglass Cave*
	Karankawa Cave*
	Medicine Man Cave*
	Pricilla's Well Cave*
	Rattlesnake Inn Cave*
	Shaman Cave*
	Unearthed Cave*
	Viper Cave*

*These sites are likely to be classified as occupied by *Batrisodes cryptotexanus* pending a taxonomic revision of *B. texanus*. If renamed, it is likely that the new species will remain protected under the ESA.

5.2.5 Listing Factor E: Other natural or manmade factors affecting its continued existence

While climate change was not listed as a threat in the Final Rule in 1998 or 1993, it is introduced as a potential threat in the Five-Year Review, although the USFWS acknowledges a lack of evidence showing a direct correlation to species impacts.

While it has been assumed that caves are less susceptible to changes occurring on the surface of the earth, some more recent data suggests that climactic changes on the surface may have an impact on cave ecosystems. Ultimately, while climate change may introduce changes to the climate of caves that could potentially impact *T. reyesi*, given the unique layout and nature of all caves, it is not possible to quantify those impacts or the effect of regional climate changes on them. Studies do suggest that cave conditions become less responsive to surface conditions the further one travels away from the cave entrance. For *T. reyesi*, this would indicate that by traveling to further depths within a cave, it would be possible to avoid the impacts of climate change. The known use of mesocavernous spaces by *T. reyesi* indicates that this is a probable natural protective mechanism for the species. Additionally, given examples like the Inner Space Caverns where the cave climate was changed considerably by the introduction of artificial entrances, light stations, and human visitation (all contributors of increased cave temperature and modified cave climate), it appears that *T. reyesi* is able to adapt to changing climactic conditions within a cave.

6.0 STATUS OF THE SPECIES

Since 1988, the known localities of the *T. reyesi* have increased from five to 172 known caves, and additional caves are regularly being discovered. For example, in 2010 biologists working with Travis County discovered five previously unknown occupied caves within the BCP preserve in Travis County: Cortana Cave, Geode Cave, F-12 Cave, IV-3 Cave, and Pond Party Pit Cave (Travis County, et. al. 2012:6, ZARA 2010:9). These additional five caves are not included in the 168 caves identified by the USFWS Five-Year Review as they were discovered after that review was complete. It is highly likely that more occupied caves will be discovered as research continues throughout Travis and Williamson counties. A timeline of the regulatory history and population milestones that support this petition is identified in Figure 3.

With each new *T. reyesi* locality found and protected, the species baseline is increased and the magnitude of the potential threats to the species is reduced. **The perceived imminent threat of development that was relevant to a known population of only five caves at the time of listing is no longer relevant given the expanded range and distribution of the species, and the known protected localities.** Even if natural or man-induced events caused the destruction of several *T. reyesi* caves, the number of protected preserve caves and the likely occupied habitat present in mesocaverns and other undiscovered void spaces would continue to support the species.

Based on the prior actions taken by the USFWS, *T. reyesi* benefits from a level of recovery comparable to that achieved for other species in previous delisting actions. In many cases, the recovery level for *T. reyesi* exceeds the acceptable recovery criteria approved by the USFWS. While known localities alone may not constitute recovery, the added benefit of extensive preserves and other regulatory actions that offer at least some protection to the species across its range further supports delisting. How the status of *T. reyesi* compares to six other species that have been delisted is represented in Table 4.

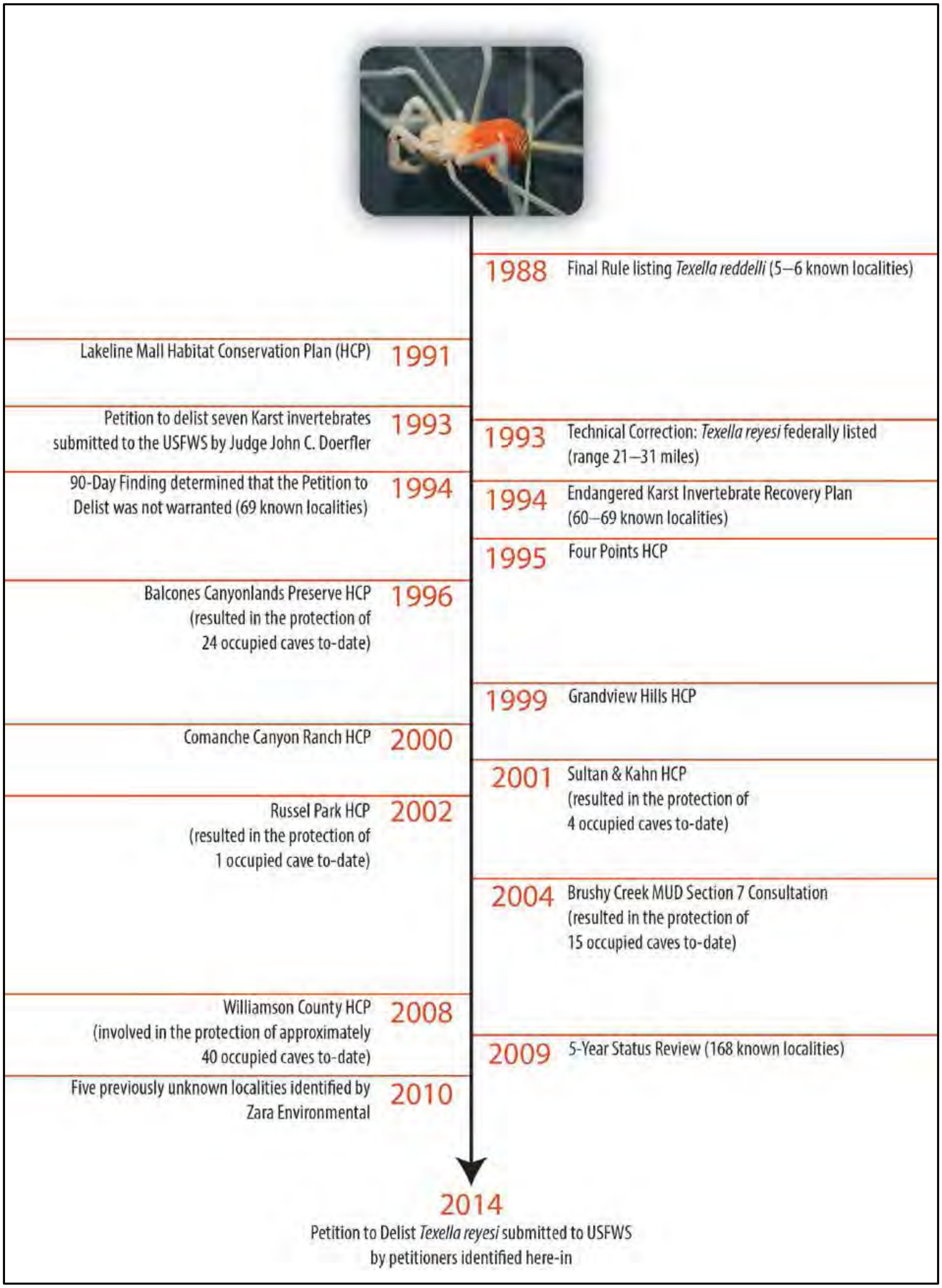

Figure 3. Timeline of regulatory actions for *Texella reyesi.*

Table 4. Comparison of *T. reyesi* to Six Prior Delisting Actions by the USFWS.

Species	Known Status at Listing	Known Status at Delisting	Reason for Delisting	Percent Increase
Pine Barrens treefrog *(Hyla andersonii)*	7 localities	150 localities	New Information	150%
Rydberg Milk-Vetch (*Astragalus perianus)*	1 locality	11 localities	New Information	1,106%
McKittrick pennyroyal *(Hedeoma apiculatum)*	7 localities	36 localities	New information	414%
Columbian White-tailed Deer (*Odocoileus virginianus leucurus*,	400-500 individuals	6,000 individuals	Designation of secure habitat zones	1,417.5%
Aleutian Canada goose (*Branta canadensis leucopareia*)	790 individuals	36,978 individuals	Increased number of individuals, threats not as severe as originally believed	4,580.75%
Robbins' Cinquefoil (Potentilla robbinsiana)	2,000 individuals	4,000 individuals	Increased number of individuals, threats not as severe as originally believed	600%
Bone Cave Harvestman *(Texella reyesi)*	5-6 localities (one *T. reddelli* and not *T. reyesi* , so actually 4-5)	Currently 172 localities; not currently delisted.	Potentially, increased number of localities, threats not as severe as originally believed, new information	3,340%

The 1994 Recovery Plan begins with a disclaimer that "recovery plans delineate the reasonable actions that are believed to be required to recover and/or protect listed species" and "approved recovery plans are subject to modification as dictated by new findings, changes in species' status, and the completion of recovery tasks" (USFWS 1994:i). These statements by the USFWS acknowledge that while recovery plans may be effective guidance tools, they are still subject to the requirements of the ESA regarding the use of the best available scientific and commercial data, and the application of the listing factors identified in Section 4(a)(1) of the ESA.

The recovery criteria identified in the 1994 Recovery Plan may be appropriate for some of the seven species included in that plan; however, the application of available scientific and commercial data indicates that those recovery criteria may be superfluous with respect to reasonably assuring the continued existence of *T. reyesi*. The establishment of USFWS-approved KFAs may require an unnecessary time and financial commitment given that the existing distribution of the species already represents a high number of protected populations, an increasing number of known localities, and a lack of significant evidence that the listing factors warrant keeping *T. reyesi* listed. While there are currently only four approved KFAs for *T. reyesi*—which is less than the minimum number of KFAs identified in the 1994 Recovery Plan, current scientific data strongly supports that the species will not become threatened with extinction in the foreseeable future.

It is not consistent with the objectives of the ESA to keep *T. reyesi* listed simply because it does not meet the specific criteria outlined in the 1994 Recovery Plan. Doing so perpetuates the trend that species included in multi-species plans are four times less likely to be improving in status *administratively* regardless of their status *biologically*. It is in the best interest of the USFWS to delist species that are

biologically recovered so that available resources can be better used to contribute to the recovery and study of species that are actually threatened with extinction.

Another standard for measuring species status is provided by the NatureServe Conservation Status guidelines (NatureServe 2014). Generally a species with five or fewer known localities is considered critically imperiled under the system; effectively justifying the listing action in 1988 when the known distribution of the species included only five to six known localities. NatureServe further classifies species as “imperiled,” “vulnerable,” “apparently secure,” and “secure.” NatureServe currently lists *T. reyesi* as imperiled. This determination is dependent upon data available only up to 1994 and cites only 64 known localities. We know now that the species has nearly three times as many known localities today. This increase in range clearly qualifies the species for reevaluation as “apparently secure,” or, indeed “secure.” Species with over 100 locations that may be uncommon are generally considered “apparently secure” under the NatureServe conservation status guidelines, which would make this the appropriate status for *T. reyesi.*

7.0 CONCLUSION

The listing of *T. reyesi* in 1988 was based on a woefully incomplete scientific understanding of the species that precluded a truly informed analysis of the threats to the species and the relevance of the ESA listing factors. In the 26 years since the species was originally listed, the available scientific and commercial data has been significantly expanded and clearly supports delisting of *T. reyesi*.

The likelihood of *T. reyesi* becoming threatened or endangered with extinction in the *foreseeable future* has been disproven due to:

1) the substantial increase in known localities since the time of listing,
2) the likelihood of identifying more occupied caves as research progresses,
3) the 94 known localities with some sort of protective measures, and
4) current regulatory water quality protection measures that provide both direct and indirect benefit to all known localities.

If the USFWS can accept that a species in decline is not threatened with extinction, it is logical to rule that a species with secure populations and showing a steady increase in known localities over time is not threatened with extinction in the foreseeable future. This being the case, it is the obligation of the USFWS, pursuant with the terms provided in the ESA, to delist the species.

Although the Petitioners believe the case for delisting *T. reyesi* presented in this petition is compelling, compelling support for delisting is not necessary in order to require the USFWS to make a positive 90-Day finding that the petitioned action may be warranted. Indeed, it is not even necessary that a petition present the bare minimum of evidence necessary to support a decision to implement the petitioned action. Therefore, USFWS could not legally deny this or any other petition on the basis that it fails to present the scientific evidence and analysis needed to justify a decision to implement the petitioned action. Rather, pursuant to ESA section 4(b)(3)(A), the question USFWS must determine at this stage is “whether the petition presents substantial scientific or commercial information indicating that the petitioned action may be warranted.” This is a relatively low-threshold burden of proof. As USFWS has explained, for the purposes of this decision, “'substantial information' is that amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted” (50 CFR 424.14(b)(1)). Given the information and analysis presented in this petition, no reasonable person could believe otherwise—the delisting of *T. reyesi* unquestionably *may* be warranted. Hence, even if USFWS believes the petition has not presented sufficient support for that action, USFWS must open a status

review of the species in connection with the required process for making a 12-month finding under ESA section 4(b)(3)(B).

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APPENDIX A

CURRENTLY PROTECTED OCCUPIED CAVES AND KNOWN MANAGEMENT ACTIVITIES

Preserve/ Conservation Area	Occupied Cave Names	Confirmed Occupied BCH	Date BCH Last Observed	Preserve Acreage	Owner	Annual Reports Available	Notes
Beck Preserve	Beck Bat Cave (TCC 2012)	Yes	5/15/1996 (Cokendolpher & Reddell 2004)	41 Acres (USFWS)			Managed by the Texas Cave Conservancy consistent with management and monitoring guidelines established in the Williamson County RHCP. Management activities include: perimeter fencing and cave gating, routine monitoring of preserve integrity (and development of annual report), control of red imported fire ant, and use of adaptive management as necessary to ensure most successful management strategy. Also includes Crevice Cave.
	Beck Crevice	Yes	9/13/1991 (Cokendolpher & Reddell 2004)				
	Beck Horse Cave (TCC 2012)	Yes	1991 (Cokendolpher & Reddell 2004)				
	Beck Pride Cave (TCC 2012)	Yes	1996 (Cokendolpher & Reddell 2004)				
	Beck Tex 2 Cave (TCC 2012)	Yes	1991 (Cokendolpher & Reddell 2004)				
Big Oak Cave Preserve	Big Oak Cave	Yes		10 Acres			Currently managed by the WCCF on behalf of TxDOT according to conditions of the Sec 7 BO
Brushy Creek MUD Preserves (Section 7)	Beck Ranch Cave	Yes	Unknown	≥100 acres	Brushy Creek MUD	Yes--Prepared by Texas Cave Conservancy annually for the USFWS; available online	Managed by the Texas Cave Conservancy consistent with management and monitoring plans developed by the Bushy Creek MUD management plan.
	Beck Rattlesnake Cave	Yes	1993 (Cokendolpher & Reddell 2004)				
	Broken Zipper Cave	Yes	1993 (Cokendolpher & Reddell 2004)				
	Joint Effort Cave	Yes	6/25/1997 (Cokendolpher & Reddell 2004)				
	O'Connor Cave	Yes	3/31/1993 (Cokendolpher & Reddell 2004)				
	Snowmelt Cave	No--believed to be occupied	Unknown				
	Beck Bridge Cave	Yes	1995 (TCC 2009; Cokendolpher & Reddell 2004)				
	Black Cat Cave	Yes	1995 (Cokendolpher & Reddell 2004)				
	Cat Hollow Bat Cave	Yes	1995 (Cokendolpher & Reddell 2004)				
	Cat Hollow Cave no. 1	Yes	1992 (Cokendolpher & Reddell 2004)				
	Cat Hollow Cave no. 2	Yes	1992 (Cokendolpher & Reddell 2004)				
	Cat Hollow Cave no. 3	Yes	Unknown				
	El Tigre Cave	Yes	1995 (Cokendolpher & Reddell 2004)				
	Formation Forest Cave	Yes	3/31/1993 (Cokendolpher & Reddell 2004)				

Preserve/ Conservation Area	Occupied Cave Names	Confirmed Occupied BCH	Date BCH Last Observed	Preserve Acreage	Owner	Annual Reports Available	Notes
	Zapata Cave	Yes	March 1994 (Cokendolpher & Reddell 2004)				
Chaos Cave Preserve	Chaos Cave* (TCC 2012) Poison Ivy Cave (TCC 2012) Under the Fence Cave (TCC 2012)	Yes Yes Yes	2000 (Cokendolpher & Reddell 2004) 4/14/2000 (Cokendolpher & Reddell 2004)	35 Acres (USFWS)			Managed by the Texas Cave Conservancy consistent with management and monitoring guidelines established in the Williamson County RHCP. Management activities include: perimeter fencing and cave gating, cricket and other biota surveys, routine monitoring of preserve integrity (and development of annual report), control of red imported fire ant, and use of adaptive management as necessary to ensure most successful management strategy. Includes a buffer zone around cave openings and restrictions on herbicide and pesticide use within the vicinity of the protected caves. Biological monitoring conducted annually by SWCA Environmental Consultants.
Cobbs Cavern KFA	Cobbs Cavern	Yes		163.15 Acres (SWCA)			Part of the Williamson County RHCP, managed in accordance with their management plan including: perimeter fencing and cave gating, cricket and other biota surveys, routine monitoring of preserve integrity (and development of annual report), control of red imported fire ant, and use of adaptive management as necessary to ensure most successful management strategy. Includes a buffer zone around cave openings and restrictions on herbicide and pesticide use within the vicinity of the protected caves.
Godwin Ranch Karst Preserve	Red Crevice Cave* (TCC 2012, TCMA 2013) Temples of Thor Cave* (USFWS 2009; TCMA 2013)	Yes Yes	5/13/1991 (Cokendolpher & Reddell 2004)	105 acres (TCMA 2013)	Texas Cave Management Association	Yes--TCMA website	Owned by the Texas Cave Management Association; managed with assistance from Zara Environmental. Management activities include: perimeter fencing and cave gating, routine monitoring of preserve integrity (and development of annual report), control of red imported fire ant, and use of adaptive management as necessary to ensure most successful management strategy. 2013 Annual Report very minimal; identifies 20 visits for cave monitoring and RIFA control in 2013, planned activities for 2014 include increased signage and development of a draft management plan (TCMA 2013).
Hidden Glen Karst Preserve	Tres Amigos Cave	Yes	Apr-94	2.6 acres (TCC website)			Managed by the Texas Cave Conservancy; management activities include: perimeter fencing and cave gating, routine monitoring of preserve integrity (and development of annual report), control of red imported fire ant, and use of adaptive management as necessary to ensure most successful management strategy.

Preserve/ Conservation Area	Occupied Cave Names	Confirmed Occupied BCH	Date BCH Last Observed	Preserve Acreage	Owner	Annual Reports Available	Notes
Karankawa KFA	Karankawa Cave* (CC/KW 2006; USFWS 2009)	Yes	4/20/1994 (Cokendolpher & Reddell 2004)	83.3 Acres			Part of the Williamson County RHCP, managed in accordance with their management plan including: perimeter fencing and cave gating, cricket and other biota surveys, routine monitoring of preserve integrity (and development of annual report), control of red imported fire ant, and use of adaptive management as necessary to ensure most successful management strategy. Includes a buffer zone around cave openings and restrictions on herbicide and pesticide use within the vicinity of the protected caves.
	Polaris Cave* (CC/KW 2006; USFWS 2009)	Yes	4/19/1994 (Cokendolpher & Reddell 2004)				
	War Party Cave (CC/KW 2006)	Yes	4/20/1994 (Cokendolpher & Reddell 2004)				
Millennium Preserve	Little Demon Caves (TCC 2012)	Yes		90 acres; 52 acres (TCC 2012)			Any future property uses must be approved by USFWS, regular on-site monitoring for vandalism, fire ants, and necessary cave-gate maintenance. Biological surveys will be conducted every three years. **Proposed KFA
	Millennium Cave (TCC 2012)	Yes					
Russell Park—Rockledge HCP Mitigation; Twin Springs Preserve KFA	Sunless City Cave (TCC 2012)	Yes		145 acres; Twin Springs Preserve 57 Acres (TCC 2012)			Includes designated Conservation Area, with a minimum 165 feet set-back from cave opening for construction, prohibition of clearing native vegetation, restrictions on use of herbicides, pesticides, and fertilizers. Managed by the Texas Cave Conservancy consistent with management and monitoring guidelines established in the Williamson County RHCP. Management activities include: perimeter fencing and cave gating, routine monitoring of preserve integrity (and development of annual report), control of red imported fire ant, and use of adaptive management as necessary to ensure most successful management strategy.
	Whitney West Cave (TCC 2012)	Yes					
Shadow Canyon Preserve	Three-Mile Cave	Yes	(USFWS 2009)	43.84 acres	Shadow Canyon Owners' Association		Management activities outlined in HCP agreement.
	Salt Lick Cave	Yes	(USFWS 2009)				
	Lizard Lounge Cave	Yes	(USFWS 2009)				
	Dwarves Delight Cave	Yes	(USFWS 2009)				
Sun City Mitigation Preserves	Apache Cave (Reddell 2000; CC/KW 2006)	Yes	December 1993 (Reddell 2000)	321.5 acres	Sun City, Del Webb Corporation	Yes--Only 9 caves are extensively monitored regularly; the rest are surveyed less frequently	Managed by the Texas Cave Conservancy consistent with management and monitoring guidelines established in the Williamson County RHCP. Management activities include: perimeter fencing and cave gating, routine monitoring of preserve integrity (and development of annual report), control of red imported fire ant, and use of adaptive management as necessary to ensure most successful management strategy.
	Choctaw Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	August 1994 (Reddell 2000)				
	Deliverance Cave No. 1 (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				

Preserve/ Conservation Area	Occupied Cave Names	Confirmed Occupied BCH	Date BCH Last Observed	Preserve Acreage	Owner	Annual Reports Available	Notes
	Deliverance Cave No. 2 (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	November 1994 (Reddell 2000)				
	Do Drop In Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	Double Dog Hole Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	Dragonfly Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	July 1994 (Reddell 2000)				
	Electro-Mag Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	Holler Hole Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	December 1999 (Reddell 2000)				
	Kiva Cave No. 1 (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	Medicine Man Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	Prairie Flats Cave (Reddell 2000; CC/KW 2006)	Yes	April 2000 (Reddell 2000)				
	Shaman Cave* (Reddell 2000; CC/KW 2006; USFWS 2009; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	Trail of Tears Cave (TCC 2012; Reddell 2000; CC/KW 2006)	Yes	April 1994 (Reddell 2000)				
	Turner Goat Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	Unearthed Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	UTE Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				

Preserve/ Conservation Area	Occupied Cave Names	Confirmed Occupied BCH	Date BCH Last Observed	Preserve Acreage	Owner	Annual Reports Available	Notes
	Venom Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	Viper Cave (Reddell 2000; CC/KW 2006)	Yes	December 1996 (Reddell 2000)				
	Woodruffs' Well Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	April 2000 (Reddell 2000)				
	Yellow Hand Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	March 1994 (Reddell 2000)				
	You-Dig-It Cave (Reddell 2000; CC/KW 2006; TCC 2012)	Yes	December 1993 (Reddell 2000)				
	Duckworth Bat Cave (CC/KW 2006)	Yes	1999 (Cokendolpher & Reddell 2004)				
	Pow Wow Cave* (Reddell 2000; CC/KW 2006; USFWS 2009; TCC 2012)	Yes	April 2000 (Reddell 2000)				
Testudo Preserve	Testudo Tube Cave	Yes		26 acres			De facto KFA; managed by the Texas Cave Conservancy on behalf of the City of Cedar Park. Activities include land management, fire ant control, restricted access, and regular cave monitoring.
Travis County Balcones Canyonlands Preserve (BCP)	Beard Ranch Cave* (RECON 1996; USFWS 2009, Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994	7,019-9,298 acres	**City of Austin Owned:** Beard Ranch Cave, Stovepipe Cave, Cotterel Cave, Fossil Cave, Spider Cave, IV-3 Cave, Pond Party Pit Cave, Cortana Cave; **Travis County Owned:** Gallifer Cave, McDonald Cave, Tooth Cave, New Comanche Trail Cave, North Root Cave, Root Cave, Geode Cave, F-12 Cave; **Privately Owned:** Eluvial Cave, Jollyville Plateau Cave, MWA Cave, Cold Cave, Fossil Garden Cave,	Yes: developed annually as a reporting requirement. Available on the BCCP website.	Once acquisition is complete, will protect between 7,019 and 9,298 acres, and 18 of 21 occupied caves. Includes individual cave preserves and three cave clusters (McNeil, Northwood, and Four Points). Additionally includes consideration for newly discovered occupied caves which may be acquired in the future. Management activities include: maintenance of native vegetation, imported fire ant control, control of disturbance by humans, and protection of water quality and nutrient input. The surface and sub-surface environments must be maintained in their natural condition with minimal vegetation disturbances. City of Austin and Travis County owned caves are either on preserves or parkland; no public access is permitted for ANY of the BCP designated caves.
	Eluvial Cave* (RECON 1996; USFWS 2009, Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	Gallifer Cave* (RECON 1996; USFWS 2009, Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	Jollyville Plateau Cave* (RECON 1996; USFWS 2009, Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994, Cokendolpher and Reddell 1995				

Preserve/ Conservation Area	Occupied Cave Names	Confirmed Occupied BCH	Date BCH Last Observed	Preserve Acreage	Owner	Annual Reports Available	Notes
	McDonald Cave* (RECON 1996; USFWS 2009, Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994		Hole-In-The-Road Cave, McNeil Bat Cave, No Rent Cave, Weldon Cave (Travis County et al. 2012)		
	MWA Cave* (RECON 1996; USFWS 2009, Travis County et al. 2012))	Yes	Elliot 1992, USFWS 1994, Cokendolpher and Reddell 1995				
	Stovepipe Cave* (RECON 1996; USFWS 2009, Travis County et al. 2012))	Yes	Elliot 1992, USFWS 1994				
	Tooth Cave* (RECON 1996; USFWS 2009, Travis County et al. 2012))	Yes	Elliot 1992, USFWS 1994				
	Cold Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	Cotterell Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	Fossil Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	Fossil Garden Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	Hole-In-The-Road Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994, September 1998 (Cokendolpher & Reddell)				
	McNeil Bat Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	New Comanche Trail Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	No Rent Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	North Root Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				

Preserve/ Conservation Area	Occupied Cave Names	Confirmed Occupied BCH	Date BCH Last Observed	Preserve Acreage	Owner	Annual Reports Available	Notes
	Root Cave (RECON 2006; Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
	IV-3 (Travis County et al. 2012)	Yes	2012 (Travis County et al. 2012; Zara)				
	Pond Party Pit (Travis County et al. 2012)	Yes	2012 (Travis County et al. 2012; Zara)				
	Cortana Cave (Travis County et al. 2012)	Yes	2012 (Travis County et al. 2012)				
	Geode Cave (Travis County et al. 2012)	Yes	2012 (Travis County et al. 2012)				
	F-12 (Travis County et al. 2012)	Yes	2012 (Travis County et al. 2012)				
	Weldon Cave* (RECON 1996; USFWS 2009, Travis County et al. 2012)	Yes	Elliot 1992, USFWS 1994				
Wilco Cave Preserve	Mongo Cave (TCC 2012)	Yes	Apr-99	130 acres; 65 acres (TCC 2012)			Managed by the Texas Cave Conservancy consistent with management and monitoring guidelines established in the Williamson County RHCP. Management activities include: perimeter fencing and cave gating, routine monitoring of preserve integrity (and development of annual report), control of red imported fire ant, and use of adaptive management as necessary to ensure most successful management strategy. **Pending KFA
	Rock Ridge Cave (TCC 2012)	Yes					
	Wilco Cave (TCC 2012)	Yes					
	Wild West Cave (TCC 2012)						
Priscilla's Well KFA	Priscilla's Cave (Reddell 2000; TCC 2012)	Yes	April 2000 (Reddell 2000)	51 acres			Maintenance of fencing, quarterly site visits, conduct annual cave fauna surveys; plans to acquire 700 acres of KFAs and manage that land in perpetuity. Each KFA will be a minimum of 40-90 acres and will be submitted to the USFWS for consideration along with a detailed management and monitoring plans for the KFA. Will additionally include management of 10 conservation areas in perpetuity--may be selected from caves included in this list.
	Priscilla's Well Cave* (Reddell 2000; USFWS 2009; TCC 2012)	Yes	April 2000 (Reddell 2000)				

* Indicates designation as a "potential KFA" in the Five-Year Review for the Bone Cave harvestman (USFWS 2009).

APPENDIX B

ESA SECTION 7 AND SECTION 10 CONSULTATIONS RELATED TO TEXELLA REYESI

HCP Name	Permit No.	Date of Issuance	Covered Species	Covered Activities	Estimated Take	Mitigation
Comanche Canyon Ranch	TE 004683-0	July 17, 2000	Golden-cheeked warbler, Tooth Cave pseudoscorpion, Kretschmarr Cave mold beetle, Bee Creek Cave harvestman, Bane Cave harvestman, Tooth Cave spider, and Tooth Cave ground beetle	Construction and operation of Comanche Canyon Ranch w/ associated roads and utilities on 110 acres of a total 446 acres.	63 ac of GCWA habitat; 26 ac directly modified, and 37 ac indirectly impacted due to urbanization. A total of 5 warbler territories taken. No impacts to karst invertebrates expected.	During land clearing/excavation in zones 1&2, a qualified geologist will remain on-site to ensure detection of any karst features. If any features are found, all construction w/in 500 feet will cease until all necessary evaluations completed.
Sultan & Kahn	TE 035525-0	May 31, 2002	Bone Cave harvestman	Construction and operation of 3 unspecified commercial developments w/associated driveways, parking lots, landscaping, utilities, and other associated infrastructure on 3.53 ac.	No direct take expected. Indirect impact to 2.585 ac of surface habitat contributing to the degradation of Beck Bat/Beck Crevice Cave to the extent that they could cease providing habitat for the BCH.	On-site minimization of impacts to the BCH by conservation measures such as native plant landscape buffers and use of Integrated Pest Management on-site. Funding for acquisition & management of one cave w/in a preserve system w/an area of at least 70 ac in Williamson or Travis Co.
Russell Park Estates	TE 051567-1	July 1, 2005	Golden-cheeked warbler	Construction of a residential development of 35-40 home sites w/attendant roads and utilities on 53.5 ac of the property.	53.5 ac of GCWA habitat directly modified, 34.4 indirectly affected by development. Will adversely impact 3-4 GCWA territories. No take for BCH is authorized.	Preservation in perpetuity of ~139.4 ac containing portions of the property identified as potentially high quality GCWA habitat; managed by applicant. Deer and bird feeders prohibited in residential yards and preserve areas. Free-roaming dogs and cats prohibited. This area contains Sunless City Cave; no impacts to karst invertebrates anticipated.
Four Points Property	PRT-808694	March 12, 1996	Golden-cheeked warbler, Tooth Cave ground beetle, and Bone Cave harvestman	Development of ~138 ac for a combination of mixed uses and residential construction w/attendant widening of Four Points Drive and utilities construction.	Puzzle Pits Cave would be covered over and surface water runoff into Twisted Elm Cave would be altered in quantity and quality. Direct modification of 138 ac of GCWA habitat, and 65 ac negatively affected. Parts of 13 warbler territories will be affected.	52 ac would be preserved and maintained; contains 5 caves known to be inhabited by Tooth Cave ground beetle and/or Bone Cave harvestman. Kretschmarr Cave mold beetle and Tooth Cave pseudoscorpion may be present in these caves. This area also contains GCWA habitat.
Grandview Hills	PRT-815447	August 27, 1999	Golden-cheeked warbler, Black-capped vireo, Tooth Cave pseudoscorpion, Kretschmarr Cave mold beetle, Bee Creek Cave harvestman, Bone Cave harvestman, Tooth Cave spider, Tooth Cave ground beetle, Jollyville Plateau salamander, and Bifurcated Cave amphipod	Construction of residential and commercial development with attendant roads and utilities on portions of the 550.3-ac Grandview Hills property.	Direct modification of 4.1 ac of potential black capped vireo (BCV) habitat. Negative impacts to 0-1 territories. Direct modification of 59.4 ac of GCWA habitat; 19 ac of habitat eliminated. Negative impacts to 6-9 territories.	**GCWA**: 313.3 ac set aside in perpetuity as a preserve for GCWA, protecting 266 ac of GCWA habitat; managed by Travis Co. for the BCP. **BCV:** 15.3 ac of potential habitat will be restored. A ~600-foot buffer to the west and southwest of Amber Cave will be provided to protect the Tooth Cave pseudoscorpion and Kretschmarr Cave mold beetle and other karst invertebrates. Amber Cave is within the 313.3 ac preserve. Greenbelt areas will provide buffers, and surface water runoff from developed areas will enter drainages downstream of the area known to contain Jollyville Plateau salamanders, and no surface water runoff from developed areas into Talus Springs Cave.
Lakeline Mall			Tooth Cave ground beetle and Bee Creek Cave Harvestman	Development of 116 ac for the construction of a regional mall and additional commercial development with attendant parking facilities.	No greater than 62 ac on the eastern portion of the site. Impacts to Underline Cave, Well Trap location #6, and Lakeline Cave are expected.	*Acquisition of karst preserve lands and known cave location for the Tooth Cave ground beetle and Bee Creek Cave harvestman. Preserve will be funded, investigated, and characterized by the applicant. Management annuity will amount to $50,000 for the life of the permit. *Contribution of $40,000 to the BCCP. *Karst ecosystem exhibit for educational purposes. *Fire ant control within the preserve.
Williamson County	TE-181840-0	October 21, 2008	Bone Cave harvestman, Coffin Cave mold beetle, golden-cheeked warbler, and black-capped vireo	Public and private development activities including road construction/maintenance, utility installation/ maintenance, pipelines, plants, schools, and land clearing.	210 caves over the life of the permit (based on average caves expected to be discovered per year over 30-year permit)	Acquisition and management of 9-15 40-to-90 acre KFAs across the KFRs, assume management of 10 existing karst conservation areas.

HCP Name	Permit No.	Date of Issuance	Covered Species	Covered Activities	Estimated Take	Mitigation
Travis County	TE-788841	May 2, 1996	Black-capped vireo, golden-cheeked warbler, Tooth Cave pseudoscorpion, Tooth Cave spider, Tooth Caveground beetle, Kretschmarr Cave mold beetle, Bone Cave harvestman, and Bee Creek Cave harvestman.	Development of residential, commercial, or industrial construction and infrastructure projects and their indirect impacts.	Loss of up to half of the known occupied BCV habitat; Loss of up to 71% of potential GCWA habitat; Loss of up to 84% of karst invertebrate habitat.	Preservation of a minimum of 30,428 ac of BCV and GCWA habitat; provide maintenance, patrol, and biological management of preserved area, and conduct biological monitoring and research activities; includes known *T. reyesi* occupied caves.
Brushy Creek MUD (Section 7)	Consultation # 2-15-F-2002-0453	September 9, 2004	Bone Cave harvestman	Development and construction of diversion and raw water transmission pipelines and associated facilities.	May occur in any occupied caves bisected by the pipeline. Take will be in the form of killing of individuals occupying areas directly adjacent to the trenching and harm due to habitat alteration.	Work with WCKF to identify and preserve additional KFAs; revegetation of disturbed areas and silt barriers up-gradient of karst openings; use of hazardous/toxic substances will be minimized; construction equipment inspected daily for leaking fluids; vehicle fueling/maintenance limited to areas away from construction areas; written contingency plan in place for hazardous/toxic substance spills; and if karst features are encountered during construction, they will be protected from adverse impacts and evaluated for potential habitat.

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APPENDIX C

KNOWN OCCUPIED *T. REYESI* CAVES

Known Occupied *T. reyesi* Caves

Abused*
Abyss
Apache*
Barker Ranch No. 1
Beard Ranch**
Beck Bat Cave*
Beck Blowing Well
Beck Bridge*
Beck Crevice*
Beck Horse*
Beck Pride*
Beck Ranch*
Beck Rattlesnake*
Beck TEX-2*
Beck Tin Can/Sewer
Bee Creek
Beer Bottle
Big Oak Cave*
Black Cat*
Blessed Virgin Cave**
Bone Cave
Broken Zipper*
Browns' Cave
Buzzard Feather
Cassidy
Cat Cave
Cat Hollow Bat
Can Hollow Cave No. 1*
Cat Hollow Cave No. 2*
Cat Hollow Cave No. 3*
Cave Coral
Chaos Cave**
Choctaw*
Cobb Drain
Cobbs Cavern***
Coke Box
Cold Cave*
Coon Scat Cave
Cortana Cave*
Cotterell Cave*
Crescent
Deliverance No. 1*
Deliverance No. 2*
Do-Drop-In*
Double Dog Hole*
Dragonfly*
Duckworth Bat*
Dwarves Delight Cave*
Easter
El Tigre*
Electro-Mag*
Elm
Eluvial**
Ensor
Eulogy
F-12*
Fence Line Sink**
Flat Rock
Flint Wash
Flowstone Rift
Formation Forest*
Fortune 500
Fossil*
Fossil Garden*
Gallifer**
Geode*
Hatchi
Hide-Away
Hole-In-The-Road*
Holler Hole*
Hollow Oak
Hourglass Cave
Inner Space Caverns
IV-3*
Jack Hammer
Jensen**
Joint Effort*
Joker
Jollyville Plateau**
Karankawa***
Killian Kavern
Kiva Cave No. 1*
Lakeline
Leachate
Lineament
Little Demon**
Little Lake
Lizards Lounge Cave*
Lobos' Lair**
Man with a Spear
Mayfield
Mayor Elliot
McDonald**
McNeil Bat Cave*
McNeil Quarry
Medicine Man*
Millennium**
Millipede
Mongo*
Mosquito
Mustard
MWA**
Near Miss
New Comanche Trail*
No Rent*
North Root Cave*
O'Connor*
Off Campus
Ominous Entrance
On-Campus
Onion Branch

*Protections afforded as described in Appendix A
**De facto KFA as acknowledged in the 5-Year Review or by Permitted Biologists
***Cave location part of an approved KFA

Outlaw	Short Stack	Undertaker
Pecan Gap	Sierra Vista	Unearthed*
Pencil Cactus	Six Meter Sink	Unemployment
Poison Ivy**	Snake Dancer	Ute*
Polaris***	Snowmelt Cave*	Vault
Pond Party Pit*	Sore-Ped	Veniuri
Posh	Spider	Venom*
Pow Wow**	Stalagroot	Vericose
Prairie Flats*	Steam**	Viper*
Price-is-Right	Step Down	War Party***
Pricilla's***	Step Stone	Waterfall Canyon
Pricilla's Well***	Stonewall Ranch	Weldon**
Purple Glass	Stovepipe**	Weldon Rattlesnake
Pussy Cat	Sunless City Cave***	West Rim
Racine Park	Swarm	Whislin Dixie
Raccoon Cave	Temples of Thor**	Whitney West***
Raccoon Lounge**	Testudo Tube*	Wilco*
Rattlesnake Inn	Texella	Wild Card
Red Crevice**	Thin Top	Wild West*
Rock Fall**	Three Mile*	Williams
Rock Ridge*	Through Trip	Williams No. 1
Rocky Horror Cave	Tooth Cave**	Wolfs' Rattlesnake**
Root*	Trail of Tears*	Woodruffs' Well*
Rootin Tootin	Tres Amigos*	WS-54**
Round Rock Breathing**	Turner Goat*	WS-71a**
Salt Lick*	Twin Springs	WS-65310**
Sam Bass Hideaway	Twisted Elm	Yamas
Scoot-Over	Under the Fence Cave**	Yellow Hand*
Serta	Underdeveloped	You-Dig-It*
Shaman**	Underline	Zapata*

*Protections afforded as described in Appendix A
**De facto KFA as acknowledged in the 5-Year Review or by Permitted Biologists
***Cave location part of an approved KFA

Administrative Record Excerpt 3

R000315 - R000337

Bone Cave Harvestman (*Texella reyesi*) 5-Year Review: Summary and Evaluation

Bone Cave Harvestman
(*Texella reyesi*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Austin Ecological Services Field Office
Austin, Texas

5-YEAR REVIEW
Bone Cave Harvestman (*Texella reyesi*)

1.0 GENERAL INFORMATION

1.1 Reviewers:

Lead Regional Office: Southwest Regional Office, Region 2
Susan Jacobsen, Chief, Threatened and Endangered Species
505-248-6641
Wendy Brown, Recovery Coordinator, 505-248-6664
Julie McIntyre, Recovery Biologist, 505-248-6657

Lead Field Office: Austin Ecological Services Field Office (AESFO)
Cyndee Watson, Endangered Species Biologist
512-490-0057 x 223

1.2 Methodology used to complete the review:

The U.S. Fish and Wildlife Service (Service) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) as required by section 4(c)(2)(A) of the Endangered Species Act (16 U.S.C. 1531 et seq.). The Service provides notice of status reviews via the Federal Register and requests information on the status of the species. This review was conducted by Cyndee Watson and Bill Seawell from the AESFO. This status review mostly relied on information summarized and cited in Balcones Canyonlands Preserve (BCP)[1] Annual Report (BCCP 2009a)[2] and the BCP cave assessment (BCCP 2009b). We also used the draft Bexar County Karst Invertebrate Recovery Plan (Bexar RP) (Service 2008), which contains new karst invertebrate research and preserve design concepts; the Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas (Travis and Williamson RP) (Service 1994), and cave data contained within AESFO' s files.

As a basic first step in assessing whether caves that contain *T. reyesi* met the downlisting recovery criteria in the Travis and Williamson RP, we compiled a list of some basic characteristics (further described in Section 2.2.3). While the Travis and Williamson RP discusses broad concepts regarding preserve design, the draft Bexar RP has an appendix that is a compilation of research to help more specifically delineate preserve boundaries that follow those basic concepts (Service 2008). These preserve design principles and characteristics describe what is needed to protect each karst feature and its surrounding

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[1] BCP - A system of preserves permanently set aside to conserve habitat for 8 endangered species (including *T. reddelli*) and 27 species of concern as part of a joint regional 10(A)(1)(B) incidental take permit PRT 788841, held by the City of Austin and Travis County.
[2] BCCP - The incidental take permit mentioned above is also referred to as the Balcones Canyonlands Conservation Plan (BCCP).

area. From the list of known locations of these species, we identified those that had the highest likelihood of meeting these characteristics. Our determinations (discussed in section 2.2.3) for each of these characteristics were based on site-specific information found in the AESFO files and on cave location and parcel data. Unless otherwise noted, all acreage estimates were calculated using Geographic Information Systems (GIS) (2008 digital aerial photography, 2006 Travis County parcel data, and 2005 Williamson County parcel data) and are subject to typical margins of error associated with GPS units, GIS, and transferring data from paper sources to digital media. These acreages and respective cave locations need to be ground-truthed (i.e., verified by site visits).

1.3 Background:

The Bone Cave harvestman, *Texella reyesi*, is a troglobite which is a species restricted to the subterranean environment. As typical of troglobites, this harvestman exhibits morphological adaptations to that environment, such as elongated appendages and loss of eyes and pigment. Troglobitic habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes and caves, which are produced by solution of bedrock) in Travis and Williamson Counties. Karst areas commonly have few surface streams; most water moves through cavities underground. Within this habitat this species depends on high humidity, stable temperatures, and nutrients derived from the surface. Examples of nutrient sources include leaf litter fallen or washed in, animal droppings, and animal carcasses. The harvestman is predaceous upon small or immature arthropods. It is imperative to consider that while these species spend their entire lives underground, their ecosystem is very dependent on the overlying surface habitat.

Texella reyesi was listed as endangered in 1988 based on the threats of: 1) habitat loss to development; 2) cave collapse or filling; 3) alteration of drainage patterns; 4) alteration of surface plant and animal communities, including the invasion of exotic plants and predators (i.e. the red-imported fire ant (RIFA), *Solenopsis invicta*), changes in competition for limited resources and resulting nutrient depletion, and the loss of native vegetative cover leading to changes in surface microclimates and erosion; 5) contamination of the habitat, including groundwater, from nearby agricultural disturbance, pesticides, and fertilizers; 6) leakages and spills of hazardous materials from vehicles, tanks, pipelines, and other urban or industrial runoff; and 7) human visitation, vandalism, and dumping; mining; quarrying (limestone); or, blasting above or in caves.

There are 168 caves known to contain *T. reyesi* in Travis and Williamson Counties, Texas (Table 1). Currently, *T. reyesi* faces the same threats that it did at the time it was listed.

1.3.1 FR Notice citation announcing initiation of this review: 75 FR 20134, April 23, 2007

1.3.2 Listing history

Original Listing
FR notice: 53 FR 36029
Date listed: September 16, 1988
Entity listed: Bone Cave harvestman (*Texella reyesi)*
Classification: Endangered

1.3.3 Associated rulemakings: In an August 18, 1993, Federal Register notice (56 FR 43818), the Service gave *T. reyesi* protection under the Act as a separate species. It had previously been listed as endangered as a part of the Bee Creek Cave harvestman (*Texella reddelli*), which was subsequently re-classified into two species, and this notice was made to ensure that it continued to receive protection under the Act.

1.3.4 Review History: Status reviews for *T. reyesi* were conducted in 1988 for the final listing of the species (53 FR 36029) and in 1994 for the Travis and Williamson RP (Service 1994).

1.3.5 Species' Recovery Priority Number at start of 5-year review: 2C

1.3.6 Recovery Plan or Outline

Name of plan or outline: Recovery Plan for Endangered Karst Invertebrates (Travis and Williamson Counties, Texas)
Date issued: 1994

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? No, the species is an arachnid, so the DPS policy does not apply.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information: The recovery plan only provides criteria for downlisting from endangered to threatened (Service 1994).

Recovery Criteria: Each species will be considered for reclassification from endangered to threatened when:

(1) Three karst fauna areas (KFA) (if at least three exist) within each karst fauna region (KFR) in each species' range are protected in perpetuity. If fewer than three KFAs exist within a given KFR, then all KFAs within that region should be protected. If the entire range of a given species contains less than three KFAs, then they should all be protected for that species to be considered for downlisting.

(2) Criterion (1) has been maintained for at least five consecutive years with assurances that these areas will remain protected in perpetuity.

There are seven KFRs (adapted from the karst fauna areas in Figure 19 of Veni & Associates' 1992 report and reproduced in Figure 2 of the Travis and Williamson RP) in Travis and Williamson counties that are known to contain listed karst invertebrate species. These regions are delineated based on geologic continuity, hydrology, and the distribution of rare troglobites.

Within each KFR, established karst preserves may be considered a KFA if they meet recovery criteria. For the purposes of the recovery plan, a KFA is an area known to support one or more locations of a listed species and is distinct in that it acts as a system that is separated from other KFAs by geologic and hydrologic features and/or processes that create barriers to the movement of water, contaminants, and troglobitic fauna. Karst fauna areas should be far enough apart so that if a catastrophic event (for example, contamination of the water supply, flooding, disease) were to destroy one of the areas, that event would not likely destroy any other area occupied by that species. To be considered "protected", a KFA must be sufficiently large to maintain the integrity of the karst ecosystem on which the species depend(s). In addition, these areas must also provide protection from threats such as red-imported fire ants (*Solenopsis invicta*) (RIFA), habitat destruction, and contaminants.

Brief summary of preserve design principles:
Much of the conservation and recovery of this endangered and cryptic species is dependent upon the long-term preservation of its habitat. Because most endangered karst invertebrates are difficult to detect during in-cave faunal surveys, their conservation strategies focus on the delineation, study, and management of occupied KFAs. Regarding size and configuration of KFAs, the Travis and Williamson RP provides some conceptual guidelines on habitat conditions that are important to karst invertebrates,

including maintaining humid conditions, air flow, and stable temperatures in the air-filled voids. Also necessary are maintaining adequate nutrient supply; preventing contamination from the surface and groundwater entering the karst ecosystem; controlling the invasion of exotic species, e.g., RIFA; and allowing for movement of the karst fauna and nutrients through voids between karst features (Service 1994).

Additional scientific information and karst preserve design guidelines are presented in the draft Bexar RP and help to further define a protected KFA (Service 2008). According to these preserve design guidelines, KFAs should include the following: 1) surface and subsurface drainage basins of at least one occupied karst feature (i.e., cave); 2) ideally a minimum of 24 to 36 hectares (ha) (59 to 89 acres (ac)) of contiguous, unfragmented, undisturbed land to maintain native plant and animal communities around the feature and protect the subsurface karst community; 3) 105 meter (m) (345 foot (ft)) radius, undisturbed area, from each cave entrance for cave cricket foraging; and 4) at least 100 m (328 ft), undisturbed, from the cave footprint to the edge of the preserve to minimize deleterious edge effects (Service 2008). The Bexar RP also recognizes various qualities of KFAs. A medium quality KFA is 16 to 24 ha (40 to 60 ac) and a high quality KFA is 24 to 36 ha (60 to 90 ac). Any karst preserve less than 16 ha (40 ac) will not count toward meeting the minimum Bexar County RP recovery criteria (Service 2008). The quality of KFAs is defined based on probability of long-term survival of the species in that area and the amount of active management necessary to maintain those species. High quality KFAs tend to be larger, require less active management, and have a higher probability of long-term species survival. Medium quality KFAs have some compromised characteristics of a high quality preserve, but still have potential for reasonable remediation. Additionally, the Bexar RP outlines perpetual management, maintenance, and monitoring necessary for ensuring a high probability of species survival at each site (Service 2008). At a minimum, these activities should include: 1) controlling RIFA; 2) installing and maintaining fencing; 3) installing, if necessary, and maintaining cave gates; and 4) monitoring of karst invertebrates and the ecosystem upon which they depend (Service 2008).

Analysis regarding whether downlisting criteria have been met:
There are currently 168 caves known to contain *T. reyesi*, spanning all 7 established KFRs in Travis and Williamson Counties, Texas (Table 1). These caves are within the North Williamson (55 caves), Georgetown (35 caves), McNeil/ Round Rock (61 caves), Cedar Park (2 caves), Jollyville Plateau (12 caves), Central Austin (2 caves), and the South Travis (1 cave) KFRs. Based on a review of available data, one karst preserve in the North Williamson County KFR currently meets the definition of a protected KFA, Priscilla' s Well KFA. Other than this one KFA, there are 20 additional tracts in the North Williamson (6 tracts), Georgetown (3 tracts), McNeil/Round Rock (6 tracts), Jollyville Plateau (4 tracts), and South Travis (1 tract) KFRs that may meet the definition of a KFA. However, more research is needed to delineate surface and/or subsurface drainage basins, confirm locations and tract acreage, and confirm management activities at all caves that have potential to be a KFA. Below is a discussion of these tracts/caves and a description of how they have the potential to meet KFA status.

North Williamson County KFR

Priscilla's Well KFA – The Williamson County Conservation Foundation owns this 20 ha (51 ac) Priscilla's Well tract[3] that was recently acquired as a land donation as part of participation in the Williamson County Regional Habitat Conservation Plan (Williamson County RHCP) for the Ronald Reagan Boulevard extension. It has two caves (Priscilla's Cave and Priscilla's Well Cave) that contain *T. reyesi* and is considered a protected KFA by the Service. The cave entrances and footprints for both caves are more than 105 m (345 ft) from the nearest edge (i.e., disturbance e.g. road or a development) (SWCA 2008). The surface and subsurface drainage basins have been delineated based on topographic maps and are included in the preserve; however, onsite verification of the delineations has not been performed (SWCA 2008). As part of the management for these caves, the Williamson County Conservation Foundation will maintain fencing, conduct quarterly site visits looking for human intrusion and RIFA, and conduct annual cave fauna surveys.

Karankawa Cave and Polaris Cave

These privately-owned caves are located in a tract that is approximately 52 ha (130 ac) and have potential to meet the definition of a KFA because of the large amount of undeveloped land in and around this tract. The cave entrances for Karankawa Cave and Polaris Cave are located >700 m (>2,296 ft) and 609 m (2,000 ft) from the nearest edge, respectively. We do not have a map of the cave footprints so we cannot measure the distance to the nearest edge (i.e., disturbance via road or a development). To our knowledge the surface and subsurface drainage basins have not been delineated for either of these caves, so we do not know if they are inside this tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Shaman Cave and Pow Wow Cave – This >40-ha (>100-ac) tract is owned by Sun City and several other owners. Two caves on this tract contain *T. reyesi* and both have potential to meet the definition of a KFA. The cave entrance and footprint for Shaman Cave are located within the tract (Verdorn 1994) and the nearest edge (i.e., disturbance via road or a development) is >210 m (>700 ft) from the cave entrance; however, the cave footprint is <15 m (<50) ft away from the property boundary (although the adjacent tract is currently undeveloped so there is a possibility of protecting the area 100 m from the cave footprint). The surface drainage basin is likely included within the preserve (Verdorn 1994); however, the subsurface drainage basin has not been delineated to our knowledge. The nearest edge to the entrance of Pow Wow Cave is 143 m (470 ft) and the cave footprint is about 126 m (415 ft) (Verdorn 1994 and aerial photos). We do not have delineations of the surface or subsurface drainage basin for this cave, so we do not know if they are included in the tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Red Crevice Cave, Temples of Thor Cave, and Thor Cave

This 42 ha (105 ac) preserve is owned by Texas Cave Management Association (TCMA) and is known as the Godwin Ranch preserve. It was established as part of the mitigation

[3] Tract – refers to a contiguous undeveloped piece of land.

for Lakeline Mall (Simon 1992). Three caves on this tract contain *T. reyesi* and each has the potential to meet the definition of a KFA. The cave entrance and footprint for Red Crevice Cave are located within the tract (Simon 1992) and the nearest edge (i.e., disturbance e.g. road or a development) is about 200 m (about 656 ft) from the cave entrance. The distance from the nearest edge to the entrance of Temples of Thor Cave and Thor Cave is 121 m (400 ft) and 192 m (630 ft) respectively. We do not have maps of the cave footprints of Temples of Thor Cave or Thor Cave so we are unsure how far they are to the edge of the preserve. The surface and subsurface drainage basins have not been delineated for these caves to our knowledge; therefore, we do not know whether they are included in this tract. As part of the management for these caves, TCMA contracts with ZARA Environmental to conduct RIFA treatment; however, no cave fauna surveys are being conducted (ZARA 2008).

<u>Jensen Cave</u>
This cave is located on a privately-owned tract that is about 60 ha (150 ac) in area and is known to contain *T. reyesi*. Due to the size of undeveloped land within and around this tract, it has potential to be a KFA. The cave entrance is located 190 m (625 ft) to the nearest edge (i.e., disturbance e.g. road or a development). We do not have a map of the cave footprint and we do not have information on whether the surface and subsurface drainage basins for this cave have been delineated, so we do not know if they are in the preserve. Also, we do not know if these caves receive any management including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

<u>Lobo's Lair Cave and Wolf's Rattlesnake Cave</u>
These caves are located on a privately-owned tract that is about 117 ha (290 ac) and are known to contain *T. reyesi*. Due to the size of undeveloped land within and around this parcel, it has potential to be a KFA. The cave entrance is located 701 m (2,300 ft) and 806 m (2,646 ft) to the nearest edge (i.e., disturbance e.g. road or a development) from Lobo's Lair Cave and Wolf's Rattlesnake Cave, respectively. We do not have a map of the cave footprint for either cave and we do not have information on whether the surface and subsurface drainage basins for these caves have been delineated, so we do not know if they are in the preserve. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

<u>Twin Springs</u>
This recently-acquired preserve is on a 58 ha (145 ac) tract and contains 1 cave that is known to contain *T. reyesi* (Sunless City Cave) but it is too close to a road to be considered a KFA. However, a second cave (location needs to be verified) on the tract may contain *T. reyesi* pending taxonomic confirmation. Williamson County has indicated they plan to submit a detailed proposal as to how this area has the potential to be a KFA. Once we receive that information, we will consider whether this preserve has potential to be a KFA.

Georgetown KFR

Round Rock Breathing Cave

This privately-owned cave is located on a 21 ha (52 ac) tract and is known to contain *T. reyesi*. Due to the size of undeveloped land within this parcel, it has potential to be a KFA. The cave entrance is located 152 m (500 ft) from the nearest edge. We do not have a map of the cave footprint and we do not have information on whether the surface and subsurface drainage basins for this cave have been delineated, so we do not know if they are in the tract. Also, we do not know if this cave receives any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Steam Cave and Fence-line Sink

These two privately-owned caves are known to contain *T. reyesi* and are on a tract that is 60 ha (150 ac). Due to the size of undeveloped land within and around this tract, it has potential to be a KFA. The distance from the cave entrances are 396 m (>1,300 ft) and 274 m (900 ft) to the nearest edge (i.e., disturbance via road or a development) from Steam Cave and Fence-line Sink, respectively. We do not have maps of the cave footprints so we are unsure how far they are to the nearest edge. The surface and subsurface drainage basins have not been delineated for these caves to our knowledge; so we do not know whether they are included in this tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Wilco and Millenium Preserve

The Wilco Preserve is a 52 ha (130 ac) tract that is adjacent to the Millennium preserve which is a 36 ha (90 ac) tract. These two preserves were established with funding from the Williamson County Conservation Foundation, the Act' s Section 6 program, and Texas Department of Transportation (TxDOT) to offset impacts to *T. reyesi* from development and to provide recreational opportunities for the citizens of Williamson County. We do not have maps of the recreational facilities that are currently in place or future planned developments in relation to where the *T. reyesi* caves are on these preserves. However, Williamson County has indicated they plan to submit a detailed proposal as to how this area has the potential to be a KFA. Once we receive that information we will consider whether these two preserves have potential to be a KFA.

McNeil/Round Rock KFR

Blessed Virgin Cave

This privately-owned cave is located in a tract that is approximately 21 ha (52 ac) and has potential to meet the definition of a KFA because of the large amount of undeveloped land in and around this tract. The cave entrance is 359 m (1,180 ft) from the nearest habitat edge; however, it is <15 m (<50 ft) to the property line. We do not have a map of the cave footprints so we cannot measure the distance to the nearest edge. To our knowledge, the surface and subsurface drainage basins have not been delineated for this cave, so we do not know if they are inside this tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Weldon Cave

This privately-owned cave is part of the BCP (BCCP 2009b) and is known to contain *T. reyesi*. It occurs on a tract that is 32 ha (80 ac) and has potential to be a KFA due to the large amount of undeveloped land in this tract. The distance from the cave entrance to the nearest edge is 106 m (350 ft) (BCCP 2009b). The distance from the nearest habitat edge to the cave footprint is 96 m (347 ft) (based on Elliott 1997 and aerial photos). The surface drainage basin has been delineated but we are unsure whether it is included in the tract (BCCP 2009b). The subsurface drainage basin has not been delineated (BCCP 2009b). Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Rockfall Cave

This privately-owned cave is located in a tract that is approximately 9 ha (24 ac) and has potential to meet the definition of a KFA only because of the large amount of undeveloped land adjacent to this tract. The cave entrance is located 185 m (610 ft) away from the nearest habitat edge and about 3 m (10 ft) from the property line. We do not have a map of the cave footprint so we cannot measure the distance to the nearest edge. To our knowledge the surface and subsurface drainage basins have not been delineated for this cave, so we do not know if they are inside this tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Raccoon Lounge Cave

This privately-owned cave is located in a tract that is approximately 117 ha (290 ac) and has potential to meet the definition of a KFA due to the large amount of undeveloped land in this tract. There is a road going through this tract; however, it is about 243 m (800 ft) from the cave entrance, which is located 198 m (650 ft) away from the nearest edge (i.e., disturbance via road or a development). We do not have a map of the cave footprint, so we cannot measure the distance to the nearest edge to the cave footprint. To our knowledge the surface and subsurface drainage basins have not been delineated for this cave, so we do not know if they are inside this tract. Also, we do not know if this cave receives any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Wyoming Springs Corridor Caves

Two caves, WS 54 and WS 71a, occur on a privately owned tract that is 117 ha (290 ac). The adjacent privately-owned tract contains cave WS 65 and is 125 ha (310 ac). All three of these caves contain *T. reyesi* and have potential to meet the definition of a KFA due to the large amount of undeveloped land in these two tracts. While there is some disturbance (i.e., edge or disturbance by roads or development) in both of these tracts, the disturbance is located about 152 m (500 ft) from the closest cave entrance (WS 54a). The distance from the nearest edge to the cave entrance of caves WS 65 and WS 71a is 274 m (900 ft) and 198 m (650 ft) respectively. We do not have maps of the cave footprints, so we cannot measure the distance from the footprint to the nearest edge. To our knowledge the surface and subsurface drainage basins have not been delineated for these caves, so we do not know if they are inside this tract. Also, we do not know if these caves receive

any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Chaos Cave Preserve

This cave preserve was established to offset impacts to *T. reyesi* due to construction of State Highway 45 North (Consultation no. 2-15-1998-F-0205; TxDOT 2003). While this preserve is only 12 ha (30 ac) it is adjacent to large areas of undeveloped land, therefore it has potential to be a KFA. The 3 caves occurring on this tract, Chaos Cave, Under the Fence Cave, and Poison Ivy Cave, all contain *T. reyesi*; however, only the first 2 caves have the potential to be KFAs because Poison Ivy Cave is only 58 m (192 ft) from the nearest edge. The distance from the nearest edge (i.e., disturbance e.g. road or a development) to the cave entrance of Chaos Cave and Under the Fence Cave is 173 m (570 ft) and 137 m (450 ft), respectively (based on TxDOT 2003 and aerial photos). The distance from the cave footprint to Chaos Cave and Under the Fence Cave is 169 m (554 ft) and 136 m (446 ft) respectively (Veni 2003 and aerial photos). The surface drainage basin for Chaos Cave may be included in the preserve (Veni 2003); however, a detailed delineation has not been conducted. The surface drainage basin for Under the Fence Cave and the subsurface drainage basins have not been delineated for these two caves. Management for all three *T. reyesi* caves on this preserve includes biological surveys every three years, biannual cave cricket surveys, and biannual RIFA surveys (TxDOT 2003).

Jollyville Plateau KFR

Cuevas (Tomen Park)

This Travis County-owned tract contains several caves with listed species and three of these caves contain *T. reyesi* (Gallifer Cave, Tooth Cave, and McDonald Cave) and may meet the definition of a KFA. This cave cluster is within a tract that is 772 ha (1,909 ac) (BCCP 2009b). While Gallifer Cave, Tooth Cave, and McDonald Cave are the only three caves that have the potential to be considered a KFA for *T. reyesi*, all of the caves and karst features within this tract contribute to the long-term viability and stability of the KFA. The entrances and footprints for all of these caves are contained within this tract. The cave entrance for Gallifer Cave is 198 m (650 ft) and the cave footprint is about 189 m (620 ft) from the nearest edge (i.e., disturbance via road or a development) (Elliott 1997, Service 2008). The Tooth Cave entrance is 73 m (240 ft) from the nearest edge and the cave footprint is about 16 m (52 ft) from the nearest edge (Elliott 1997, Service 2008). The cave footprint distance for Tooth Cave was measured using the ground-penetrating radar map by Veni (2006). The cave entrance of McDonald Cave is 365 m (1,200 ft) to the nearest edge (BCCP 2009b) and the distance from the nearest edge to the cave footprint is about 335 m (1,099 ft) (based on Elliott 1997 and aerial photos). The surface and subsurface drainage basins for Gallifer Cave and Tooth Cave are included in this tract (Veni 2006). The surface drainage basin for McDonald Cave has been delineated and is included in the tract; however, the subsurface drainage basin has not been delineated (BCCP 2009b). As part of the management for these caves, the Travis County BCP staff conducts quarterly cave cricket exit counts, maintains the perimeter fences, and conducts biannual surface monitoring to look for signs of trespass and RIFA (BCCP 2009a). They also conduct an annual faunal survey at Gallifer Cave, quarterly

faunal surveys at Tooth Cave, and quarterly faunal surveys at McDonald Cave (BCCP 2009a).

Stovepipe Cave
The City of Austin owns this cave and it is part of the BCP (BCCP 2009a). It is known to contain *T. reyesi*. This 21 ha (52 ac) tract has a narrow connection to more than 1,695 ha (4,189 ac) of additional BCP land (BCCP 2009b) and the cave entrance and footprint are more than 105 m (345 ft) from any disturbance. The surface drainage basin is protected and included in the tract; however, the subsurface drainage basin has not been delineated (BCCP 2009a, b). As part of management for the cave, the City of Austin maintains the perimeter fence and conducts quarterly surface monitoring looking for human intrusion, implements RIFA control using boiling water, and conducts biannual cave fauna surveys (BCCP 2009a, b).

Four Points
This privately-owned and managed 21 ha (52 ac) tract has been preserved for the benefit of endangered karst invertebrates (Service 1994) and is considered part of the BCP[4]. Three caves in this tract contain *T. reyesi* (MWA Cave, Eluvial Cave, and Jollyville Plateau Cave), and have potential to meet the definition of a KFA. The distances from the nearest edge (e.g. road or development) are 128 m (420 ft), 152 m (500 ft), and 213 m (700 ft) from the entrance of MWA cave, Eluvial Cave, and Jollyville Plateau Cave, respectively (BCCP 2009b). The distances from the nearest edge to the cave footprint are 115 m (380 ft), 143 m (471 ft), and about 137 m (450 ft) to MWA Cave, Eluvial Cave, and Jollyville Plateau Cave, respectively (per aerial photography and Elliot 1997). This tract is adjacent to more than 162 ha (400 ac) of BCP land. The surface drainage basins have been delineated for all three of these caves but we are unsure if they are in the preserve (BCCP 2009b). The subsurface drainage basins have not been delineated (BCCP 2009b). As part of management for these caves, a perimeter fence was installed and RIFA are treated at least twice a year (ACI 2003, 2004, 2005, 2006, 2007).

Beard Ranch Cave
This City of Austin-owned cave is known to contain *T. reyesi* and is part of the BCP. It occurs on a tract that is 1,695 ha (4,189 ac) in area (BCCP 2009b). Due to the large amount of undeveloped land in this tract, it has the potential to be a KFA. The distance from the cave entrance to the nearest edge (i.e., disturbance due to road or a development) is 723 m (2,375 ft) (Dolph Scott, City of Austin, pers. comm., 2009). We do not have a map of the cave footprint, so we are unsure whether it is in the tract. The surface drainage basin is protected and included in the tract. The subsurface drainage basin has been delineated, but we are unsure whether it is in the tract (BCCP 2009b). As part of management for the cave, the City of Austin BCP staff conducts quarterly surface monitoring (BCCP 2009b).

[4] If preserves are established within the BCCP acquisition boundaries, they are considered part of the BCCP and contribute to the total acreage of the preserve system (Rose Farmer, Travis County, pers. comm. 2008).

South Travis County KFR

Barker Ranch Cave No. 1

This cave is located on the City of Austin' s Water Quality Protection Lands on a tract that is 32 ha (81 ac) in area and contains *T. reyesi*. Due to the size of undeveloped land within and around this parcel, it has potential to be a KFA. The cave entrance is located 823 m (>2,800 ft) to the nearest edge (i.e., disturbance via road or a development). We do not have a map of the cave footprint and we do not have information on whether the surface and subsurface drainage basins for this cave have been delineated, so we do not know if they are in the tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Table 1. Distribution of *T. reyesi*

Cave Name	Size of tract (ac)*	Notes
North Williamson KFR		
Priscilla's Well Cave	51	KFA
Karankawa Cave	130	potential KFA
Polaris Cave	130	potential KFA
Shaman Cave	100	10-ac setback in 100-ac undeveloped parcel; potential KFA
Pow Wow Cave	100	10-ac setback in 100-ac undeveloped parcel; potential KFA
Red Crevice Cave	105	Lakeline Mall mitigation; potential KFA
Temples of Thor Cave	105	Lakeline Mall mitigation; potential KFA
Thor Cave	105	Lakeline Mall mitigation; potential KFA
Jensen Cave	~150	potential KFA
Lobo's Lair	290	potential KFA
Wolf's Rattlesnake Cave	290	potential KFA
Flat Rock Cave	290	close to an edge
Twin Springs Cave	145	Williamson County Conservation Foundation
Sunless City Cave	145	close to a road
Snake Dancer Cave	130	1-ac setback
Prairie Flats Cave	3	3-ac setback
Abused Cave	15	
Williams Cave No. 1	15	
Cobb Drain Cave	?	close to road?
Coke Box Cave	?	close to road?
Duckworth Bat Cave	~10	
Cat Cave	~11	
Salt Lick Cave	6	
Salt Lick Cave	6	
3 Mile Cave	2	close to road?
Lizard's Lounge Cave	14	

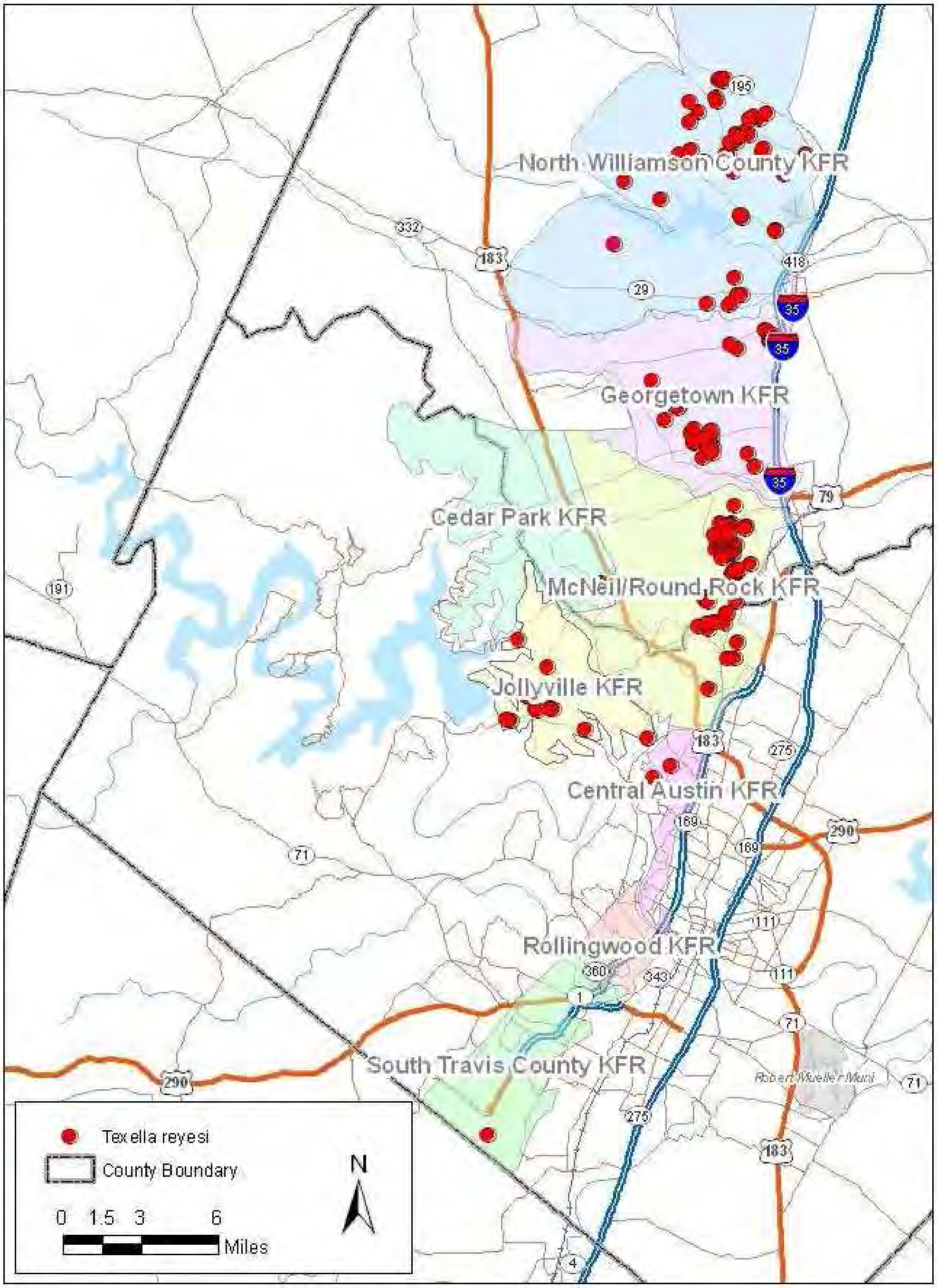
Dwarves Delight Cave	14	
Apache Cave	5	
Double Dog Hole Cave	5	
Choctaw Cave	4	3-ac setback
Ute Cave	37	15-ac setback
Venom Cave	37	15-ac setback
Unearthed Cave	37	
Deliverance No. 1 Cave	26	13-ac setback
Deliverance No. 2 Cave	26	13-ac setback
Trail of Tears Cave	26	14-ac setback
Do Drop In Cave	8	5- ac setback
Dragonfly Cave	13	8-ac setback
Electro-Mag Cave	15	8-ac setback
Kiva Cave No. 1	3	
Medicine Man Cave	12	8-ac setback
Turner Goat Cave	30	4-ac setback
You Dig It Cave	30	2-ac setback
Woodruff's Well Cave	10	1-ac setback
Yellow Hand Cave	2	1-ac setback
Holler Hole Cave	6	4-ac setback
Viper Cave	?	
Buzzard Feather Cave	~30	
Hourglass Cave	~30	
Cassidy Cave	<1	
Pussy Cat Cave	<2	
Rattlesnake Inn Cave	>1000	close to road
Texella Cave	<1	
Waterfall Canyon Cave	2	close to edge
Georgetown KFR		
Round Rock Breathing Cave	52	potential KFA
Fortune 500 Cave	52	close to edge
Ominous Entrance Cave	52	close to a road
Steam Cave	~150	potential KFA
Fence-line Sink	~150	potential KFA
Mongo Cave	130	Wilco Preserve
Wilco Cave	130	Wilco Preserve
Wild West Cave	130	Wilco Preserve
Rock Ridge Cave	130	Millennium Preserve
Through Trip Cave	90	Millennium Preserve
Little Demon Cave	90	Millennium Preserve
Millennium Cave	90	developed; ~100' from road
Yamas Cave	<14	

Mayfield Cave	?	
Bone Cave	?	
Brown^s Cave	<1	
Elm Cave	<1	developed; close to houses
Formation Forest Cave	linear	<10-ac setback
Posh Cave	<10	<20' from road
Step-Down Cave	<2	
Inner Space Cavern	4	150' from road
Man-With-A-Spear Cave	12	
Mayor Elliott Cave	~60	In 5-ac greenspace
Mosquito Cave	5	In 5-ac greenspace
Onion Branch Cave	5	
Off Campus Cave	<1	
On Campus Cave	40	close to edge
Price Is Right Cave	<1	
Rootin Tootin Cave	<5	
Short Stack Cave	linear	
Sierra Vista Cave	<1	
Snowmelt Cave	<1	
Tres Amigos Cave	<2	
Zapata Cave	linear	
Flowstone Rift Cave	7	
McNeil/Round Rock KFR		
Blessed Virgin Cave	52	potential KFA
Weldon Cave	80	potential KFA
Rockfall Cave	24	potential KFA because adjacent to undeveloped land with adequate acreage to be KFA
Raccoon Lounge Cave	290	potential KFA
WS-54	290	potential KFA
WS-71a	290	potential KFA
WS-65310	310	potential KFA
Chaos Cave	30	Chaos Cave preserve; potential KFA because adjacent to undeveloped land
Beck Tex-2 Cave	41	
Beck Horse Cave	41	
Beck Pride Cave	41	
Beck Bat Cave	41	
Flint Wash Cave	?	
Beck Crevice Cave	?	
Beck Blowing Well Cave	?	
Beck Sewer Cave	10	
Beck's Tin Can Cave	10	
Black Cat Cave	10	

Beer Bottle Cave	42	
Beck Ranch Cave	?	
Beck Rattlesnake Cave	?	
Broken Zipper Cave	?	54-acre greenbelt
Joint Effort Cave	?	26-acre greenbelt?
Beck Bridge Cave	26	
Cat Hollow Bat Cave	2	
Cat Hollow Cave #1	3	
Cat Hollow Cave #2	26	
O'Connor Cave	26	in greenbelt
Cave Coral Cave	28	
Poison Ivy Cave (not all CCF)	30	Chaos Cave preserve
Under-the-fence Cave	30	Chaos Cave preserve
El Tigre Cave	?	
Crescent Cave	?	
Ensor Cave	?	
Eulogy Cave	?	
Leachate Cave	?	
Jackhammer Cave	?	
Scoot Over Cave	?	
Serta Cave	?	
Underdeveloped Cave	?	
Undertaker Cave	?	
Vericose Cave	?	
Wild Card Cave	?	
Joker Cave	?	
Hollow Oak Cave	?	
Lineament Cave	?	
McNeil Bat Cave	20	
No Rent Cave	150?	cave may be mapped incorrectly
Fossil Garden Cave	?	
Millipede Cave	?	in school courtyard
Mustard Cave	?	mapped incorrectly
Pecan Gap Cave	230	close to road
Pencil Cactus Cave	230	close to road
Rocky Horror Cave	32	close to road realignment
Sam Bass Hideaway Cave	?	close to road
Stepstone Cave	?	
Swarm Cave	?	
Hole-In-The-Road Cave	?	
Cold Cave	8	

War Party Cave	32	near 2 subdivisions
Cedar Park KFR		
Lakeline Cave	<1	
Underline Cave	developed	
Jollyville Plateau KFR		
Gallifer Cave	1,909	BCP; potential KFA
Tooth Cave	1,909	BCP; potential KFA
McDonald Cave	1,909	BCP; potential KFA
Root Cave	1,909	BCP; not KFA by itself but other caves in tract are potential KFAs
Stovepipe Cave	55	potential KFA
MWA Cave	52	Four Points; potential KFA
Eluvial Cave	52	Four Points; potential KFA
Jollyville Plateau Cave	52	Four Points; potential KFA
Beard Ranch Cave	4,189	BCP owned; potential KFA
Geode Cave	145	close to road
New Comanche Trail Cave	254	Travis County owns and will monitor the entrance and conduct faunal surveys; close to road
Twisted Elm Cave	3	
Central Austin KFR		
Cotterell Cave	20	
West Rim Cave	?	
South Travis County		
Barker Ranch Cave No. 1	81	City of Austin-owned

*Unless otherwise noted all acreage estimates were calculated using Geographic Information Systems (GIS) (2008 digital aerial photography, 2006 Travis County parcel data, and 2005 Williamson County parcel data) and are subject to typical margins of error associated with GPS units, GIS, and transferring data from paper sources to digital media. These acreages and respective cave locations need to be ground-truthed (i.e., verified by site visits). Also caves that appear to have enough acreage to qualify as a KFA did not meet all other recovery criteria, e.g. distance to edge, surface, or subsurface drainage basins were not included in the tract.



Map 1. *T. reyesi* Distribution

Climate Change
According to the Intergovernmental Panel on Climate Change (IPCC) (2007) "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years (IPCC 2007). It is very likely that over the past 50 years: cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). It is likely that: heat waves have become more frequent over most land areas, and the frequency of heavy precipitation events has increased over most areas (IPCC 2007). To date, these changes do not appear to have had a negative impact on *T. reyesi*.

The IPCC (2007) predicts that changes in the global climate system during the 21st century are very likely be larger than those observed during the 20th century. For the next two decades a warming of about 0.2°C (0.4°F) per decade is projected (IPCC 2007) Afterwards, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 0.6°C to 4.0°C (1.1°F to 7.2°F) with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007). The IPCC says it is very likely hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007). There is also high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to climate change (IPCC 2007). Milly et al. (2005) project a 10–30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models.

Although climate change was not identified as a threat to *T. reyesi* in the original listing document or in the recovery plan, the species' dependence on stable temperatures and humidity levels opens the possibility of climatic change impacting this species. Therefore, while it appears reasonable to assume that *T. reyesi* may be affected, we lack sufficient certainty to know how climate change will affect this species.

2.3 Synthesis

According to recovery criterion (1) in the Travis and Williamson RP, three KFAs within each KFR should be protected. Protection is defined as an area sufficiently large to maintain the integrity of the karst ecosystem on which the species depends. These areas must also provide protection from threats such as RIFA, habitat destruction, and contaminants. Recovery criterion (2) requires at least five consecutive years of a cave meeting KFA status and that perpetual protection of these areas is in place. Since these species were listed in 1988, there have been significant steps toward protecting caves in which they occur and meeting the downlisting criteria.

Although *T. reyesi* is known from 168 caves occurring within 7 KFRs, at this time only 1 karst preserve, located in the North Williamson County KFR, meets the definition of a protected KFA - the Priscilla' s Well KFA. Other than this 1 KFA, there are 20 other tracts distributed in the North Williamson, Georgetown, McNeil/Round Rock, Jollyville Plateau, and South Travis KFRs, that may meet the definition of a KFA. However, more research needs to be conducted to delineate surface and/or subsurface drainage basins, confirm locations and tract acreage, and confirm management activities at caves that have potential to be a KFA. Once the needed analysis is accomplished and these tracts demonstrate that they meet the full requirements of a KFA, the fulfillment of recovery criterion (1) can progress. If a cave is determined to be a KFA, then information relating to recovery criterion (2) should be gathered and/or implemented to meet downlisting status. Based on additional research and/or implementation/confirmation of certain management activities, we should be able to make this determination. Until such time, we do not recommend a change in listing status for these species.

3.0 RESULTS

3.1 Recommended Classification:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**:
 ____ *Extinction*
 ____ *Recovery*
 ____ *Original data for classification in error*
__X_ **No change is needed**

3.2 New Recovery Priority Number: No change

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Within the **Jollyville Plateau KFR**, fulfillment of the following actions will meet qualifications for the creation of KFAs on City of Austin lands included in the BCP:
  - Delineate the subsurface drainage basin for Stovepipe Cave, Beard Ranch Cave, and McDonald Cave located in Cuevas (Tomen Park) tract.
  - Verify footprint and subsurface drainage of Beard Ranch Cave.

- Determine the footprint, surface and subsurface drainage basins, and establish RIFA control, management of trespass, and monitoring of *T. reyesi* for Barker Ranch Cave No. 1, located in **South Travis County KFR**, owned by the City of Austin.

- To progress toward KFA status, work with landowners or organizations to confirm locations and tract acreage, determine footprints, and/or delineate surface and subsurface drainage basins for the following privately-owned caves:
  - In **North Williamson County KFR**: Karankawa and Polaris; Shaman and Pow Wow; Red Crevice, Temples of Thor, and Thor; Jensen; Lobo' s Lair; Wolf's

Rattlesnake
- In **Georgetown KFR**: Round Rock Breathing; Steam and Fence-line Sink
- In **McNeil/Round Rock KFR**: Blessed Virgin; Weldon; Rockfall; Raccoon Lounge; Wyoming Springs Corridor; Chaos Cave Preserve
- In **Jollyville Plateau KFR**: Four Points complex – MWA, Eluvial, Jollyville Plateau caves; Cuevas cave complex – Tooth, McDonald

- Confirm and/or implement RIFA control and other management activities with the cooperation of landowners at the following privately-owned caves to progress toward attaining KFA status:
  - In **North Williamson County KFR**: Karankawa and Polaris; Shaman and Pow Wow; Jensen; Lobo' s Lair and Wolf's Rattlesnake
  - In **Georgetown KFR**: Round Rock Breathing; Steam and Fence-line Sink
  - In **McNeil/Round Rock KFR**: Blessed Virgin; Weldon; Rockfall; Raccoon Lounge; Wyoming Springs Corridor

- Apply recovery criterion 2 to any caves that meet KFA status.

- Draft delisting criteria and revaluate the status of the species in accordance with those criteria.

- Considering the geographic distance between northern (North Williamson, Georgetown, McNeil/Round Rock, Cedar Park, Jollyville Plateau, Central Austin KFRs) and southern (South Travis KFR) cave where this species occurs, the fact that they are separated by a major hydrologic divide (Colorado River), and that some northern caves overlap with the range of the closely related Bee Creek Cave harvestman (*Texella reddelli*), genetic analyses to confirm the presence of *T. reyesi* are needed.

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FISH AND WILDLIFE SERVICE
5-YEAR REVIEW for the Bone Cave Harvestman (*Texella reyesi*)

Current Classification: endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__x__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: n/a

Review Conducted By: Cyndee Watson, Austin Ecological Services Field Office, Austin, Texas

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve ______________________ Date 6/26/09

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Ecological Services, Fish and Wildlife Service, Region 2

Signature Nancy G Gloman Date 12-4-09

Administrative Record Excerpt 4

R001734 - R001830

Examining possible foraging differences in urban and rural cave cricket populations: Carbon and nitrogen isotope ratios ($\delta^{13}C$, $\delta^{15}N$) as indicators of trophic level

Examining possible foraging differences in urban and rural cave cricket populations: Carbon and nitrogen isotope ratios ($\delta^{13}C$, $\delta^{15}N$) as indicators of trophic level

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prepared for:
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Cover: *Cicurina varians* (Araneae) in web in Surprise Sink, Bexar County, Texas. Note *Pseudosinella violenta* (Collembola) in lower left and fresh fecal pellets of *Ceuthophilus* sp. to left of center. Photo by Jean K. Krejca.

Abstract

The energy regime in small Texas caves differs significantly from many caves of the better studied eastern United States in that surface-foraging cave crickets (*Ceuthophilus secretus* and *Ceuthophilus* "species B") are major contributors to these systems. The federally listed endangered cave invertebrates of Travis, Williamson, and Bexar counties, Texas, are dependent on these crickets to transport energy from the surface to the cave environment. Using stable isotope analysis in combination with in-cave counts of animal life we examined foraging differences between *S. invicata* and cave cricket populations in nine caves chosen based on their low, medium, and high levels of human impact. Surface foraging cave crickets do not utilize the same food resources as as *Solenopsis invicata*, rather, *S. invicta* functions at the same trophic level as *Ceuthophilus cunicularis*, a cave-limited species, and also feeds on surface-inhabing invertebrates which are not part of the cave ecosystem. The trophic position of the entire cave invertebrate community differed significantly between all three levels of human impact, for both $\delta^{13}C$ and $\delta^{15}N$. Numbers of individuals of all cave taxa, including *Ceuthophilus* spp., are correlated with the level of human impact. As the percentage of impervious cover and percentage of impacted area increased, the total number of cave taxa decreased. This trend held true when either 11.2 or 90 acres around the cave entrance were considered in scoring the level of impact. Additionally, the total number of individuals of other taxa recorded from the caves was strongly correlated with the total number cave cave crickets. Maintining land in a natural state within the foraging range of cave crickets (*C. secretus* and *C*. species B), and controlling the fire ant, *S. invicta*, are therefore important considerations in the management of Texas' federally listed endangered cave invertebrates.

Introduction

Although several leading karst researchers consider primary energy inputs in karst systems to be dissolved and particulate organic carbon entering through sinkholes, pits, soils, and epikarst (Simon *et al*. 2007), this is not the case for many caves in central Texas, some of which are home to federally listed endangered invertebrates (USFWS 1988, 1993, 2000) or closely related, often rare taxa (Reddell 2001, Reddell and Cokendolpher 2001a). The majority of these caves are small, and few of them harbor large numbers of bats. These energy poor caves primarily receive energy from detritus and surface animals that fall or are washed into the caves and from energy brought into the caves by cave crickets (*Ceuthophilus secretus*, *Ceuthophilus* "species B," and perhaps *Ceuthophilus cunicularis*) and other trogloxenes such as the harvestman (*Lieobunum townsendii*). Most of these caves are dry – that is, they lack streams, and only rarely receive large influxes of water during storm events. From a hydrological perspective, it is the drainage basin of a cave that is typically thought of as the unit that defines energy flow into caves (Simon *et al*. 2007), but many small central Texas caves were developed in a phreatic environment, and have little modern catchment. In these cases, cave crickets are likely most important a a primary energy input, not water flow, and it is their foraging range, not (just) the drainage basin that is the appropriate unit for analyzing energy flux. Cave crickets contributions to the caves' carbon budget are quite significant (Lavoie *et al*. 2007; Taylor *et al*. 2003, 2004, 2005) because they forage widely on the surface and then roost in the caves during the daytime, ultimately contributing their carbon to the cave ecosystem (Lavoie *et al*. 2007; Taylor *et al*. 2003, 2004, 2005).

We know a great deal about the ecology of caves in general (Culver 1982, Howarth 1983, Poulson and White 1969, Vandel 1965). In many of the caves, nutrients appear to be concentrated near the cave entrance, arriving in the form of falling organic debris and the feces and bodies of various organisms (Peck 1976). Deeper in the caves of central Texas, the feces, eggs, and bodies of *Ceuthophilus* spp. appear to comprise a more important energy source. All of the above generalizations vary widely

from cave to cave, but may serve as a conceptual starting point for understanding the cave communities of central Texas.

The red imported fire ant (*Solenopsis invicta* Buren, RIFA) has been shown to enter and forage in caves in central Texas (Elliott 1992, 1994; Reddell 2001; Reddell and Cokendolpher 2001b, Taylor *et al*. 2003). Land managers with an interest in protecting the rare and endangered karst invertebrates have expended considerable financial resources in an attempt to control RIFA activity around cave entrances. Effective control is accomplished through the killing of individual mounds with boiling water or steam applications which must be repeated on a regular basis. The area to be treated includes susceptible area around the cave entrance or cave footprint, with the intention of excluding the ants from the cave. As the foraging range of the red imported fire ant is about 25 meters, the area to be treated is at least 0.19 hectares, more if the footprint of the cave determines treatment area.

Control efforts directed at *S. invica* are further complicated by the foraging range of cave crickets. *C. secretus* forages at night on the surface and roosts in the caves during the day. Elliott (1992), working with *C. secretus* and a closely related, undescribed species (*Ceuthophilus* “species B”), noted that “Cave crickets mostly feed within 5 or 10 m of the cave entrance, but large adults may travel 50 m or more.” Based on Elliott's (1992, 1994) work, it was thought that most cave crickets forage within 30 m of the entrances of caves (Reddell and Cokendolpher 2001b). Because of the presumed interactions (competition and/or predation) of red imported fire ants and cave crickets on the surface, land managers have used this figure to enlarge the RIFA treatment area around cave entrances. Recent research by Taylor *et al*. (2003, 2004, 2005) has demonstrated that *C. secretus* forages more than 100 m from cave entrances. This figure greatly increases the area that would need to be treated to avoid fire ant/cave cricket interactions above ground, and land managers have valid concerns about costs and other logistics associated with treating these larger areas.

One issue that is poorly understood with the cave crickets of central Texas (and, indeed, elsewhere), is their food preferences. Elliott (1992) made observations on

foraging by *C. secretus* and an undescribed species[1], noting they "were mostly seen on foliage, dead leaves, lichens on sticks, and grass, but they were not chewing although they used their palpi to probe the substrate." Elliott (1992) also observed a cave cricket with a dead RIFA in its mandibles. According to Reddell (personal communication, August 2001), adults of the two *Ceuthophilus* species that Elliott worked with in Travis and Williamson counties seem to be dominant at different times of year (Elliott 1992). Taylor *et al*. (2003) found that *C. secretus* tended to abandoned rich food sources (bait stations) when RIFA began recruiting large numbers of individuals to the food resource, thus demonstrating that RIFA / *C. secretus* may compete for resources, and that RIFA can outcompete *C. secretus* at least under experimental conditions. Because *Ceuthophilus secretus* forages more than 100 meters from cave entrances (Taylor *et al*. 2003, 2004, 2005), there are strong implications for preserve design.

Our general knowledge of the biology of cave-inhabiting crickets of the genus *Ceuthophilus* is surprisingly unbalanced. While we know a good deal about seasonality, reproduction, physiology, behavior, laboratory rearing, parasites and genetic variation of some species (e.g., Allegracci *et al*. 1991; Caccone and Sbordoni 1987; Campbell 1976; Cockley *et al*. 1977; Chinn and Arnaud 1993; Cokendolpher *et al.* 2001; Cokendolpher 2001; Cyr *et al.*1991; Eades 1964; Hubbell and Norton 1978; Leja and Poulson 1984; Lamb and Willey 1987; Nagel and Cade 1983, Northup and Crawford 1992; Northup *et al*. 1993; Northup and Kuper 1987; Poulson *et al*. 1995; Richards 1961; Robaux *et al*. 1976; Sbordoni *et al*. 1981; Smith and Campbell 1975; Studier 1996; Studier *et al*. 1986; Studier *et al*. 1987a,b; Studier *et al*. 1988; Studier *et al*. 1991; Studier *et al*. 2002; Studier and Lavoie 1990; Taylor *et al*. 2007; Turner 1915; Webb *et al*. 1977; Yoder *et al*. 2002), we know little about foraging activities, trophic position and food items of cave-inhabiting rhaphidophorids. In southern New Mexico, Campbell (1976) noted both animal and plant material in the stomachs the cave-inhabiting cricket *Ceuthophilus conicaudus*, and Cokendolpher *et al.* (2001) collected the cavernicoles *Ceuthophilus carlsbadensis* and *Ceuthophilus longipes* at a variety of bait types (jelly, tuna, and rancid liver), with bait preferences varying seasonally. In addition Krejca and

[1] This work was carried out in Travis and Williamson counties. The undescribed species is *Ceuthophilus* "species B." A third species present in central Texas caves, *C. cunnicularis*, is rarely observed leaving caves to forage.

Meyers (2005) attracted *C. carlsbadensis* and *C. longipes* to bait stations using cat food, but showed that they also eat human food scraps. At Fort Hood, Texas, Taylor *et al*. (2004) showed that isotopes could be used to characterize the trophic structure of cave ecosystems, and the present study expands on that work.

In summary, we have limited knowledge about foraging by the cave cricket species occurring in central Texas, *C. secretus*, *C.* species B and *C. cunicularis*. It is generally thought that cave crickets are scavengers or omnivores. We have some evidence (Taylor *et al*. 2003) that they compete for food resources with the *S. invicta*. If the crickets and ants are utilizing different food sources and fire ants do not depredate the crickets, the foraging range of the crickets may not need to be protected[2], and thus the implications for control of fire ants at caves could be significant.

If land managers are attempting to manage landscapes around cave entrances to protect rare and endemic troglobites, they must gain an understanding of what components of the epigean flora and fauna comprise major constituents of the energy brought into caves by the keystone trogloxenes, *C. secretus* and *C.* species B. It is reasonable to presume that protection of the cave fauna would be facilitated by encouraging populations or communities of epigean elements that are major contributors to the diets of *C. secretus* and *C.* species B. Enhancing our understanding of food web relationships within and among caves could prove useful in guiding management decisions.

The federally listed endangered karst invertebrates of Travis, Williamson, and Bexar counties, Texas, are dependent on energy brought into the caves. Cave crickets, *C. secretus* and *C.* species B, are important in transporting energy from the surface to the cave environment. One of the leading threats to the cave faunas in these counties is urbanization (USFWS 1988, 1993, 2000, 2003). As development increasingly encroaches on the foraging range of the cave crickets, there may be dramatic shifts in the composition of the available food supply. Therefore, quantifying the importance epigean food resources which needed to be maintained around cave entrances to help

[2] This scenario is relatively unlikely: Two of us (SJT & JKK) have observed both the fire ants and the cave crickets feeding at (unnatural) tuna bait stations, and also have seen *Solenopsis invicta* scavenging on the body of *C. secretus* – if significant *C. secretus* mortality occurs on the surface due to *S. invicta* predation, the cricket foraging range should still be protected.

ensure the natural flow of nutrients into the caves is a high priority. When preserve areas are small, crickets may need to forage in habitats that appear to be sub-optimal. However, it is also possible that urban landscapes (e.g., mowed grassland) may provide sufficient forage for the crickets.

Here, we use stable isotope analysis in combination with in-cave counts of animal life to examine foraging differences between *S. invicata* and cave cricket populations in urban and rural settings in relation to available food supply.

Methods

Carbon and Nitrogen isotope ratio analysis

Stable isotopes are popular tools for investigating ecosystems (Griffiths 1998, Lajtha and Michener 1994, Peterson and Fry 1987, Rounick and Winterbourn 1986, Rundel *et al*. 1988). The stable isotopes of nitrogen and carbon occur in virtually all animal tissues (Peterson and Fry 1987), and their ratios ($\delta^{13}C$, $\delta^{15}N$) have been used to track the movement of energy through a food web (Cabana and Rasmussen 1994, Fry and Sherr 1984, Herrera *et al*. 1998, Magnusson *et al*. 1999., McNabb *et al*. 2001, Neilson *et al.* 2002, Ostrom *et al*. 1997, Polz *et al.* 1998, Ponsard and Arditi 2000, Sanzone *et al.* 2003, Scheu and Falca 2000, Tayasu *et al*. 1997, Whitledge and Rabeni 1997) and to help identify the food sources of animals which are difficult to observe in the wild (e.g., Fry *et al*. 1978, Hollows *et al*. 2002, Markow *et al.* 2000, Mihuc and Toetz 1994, Neilson *et al.* 2000, Rico-Gray and Sternberg 1991). These isotope "signatures" essentially represent a running average[3] of the feeding history of an organism (O'Reilly *et al*. 2002), and thus are not as biased as individual observations of instances of food resource utilization. Rather, this signature depends on the turnover rate of the isotopes in the tissue of the animals being examined. Species at higher trophic levels typically have enriched $\delta^{15}N$ relative to their prey (e.g., Oelbermann and Scheu 2002), but often utilize a variety of food sources (Pain 1988, Persson 1999, Post 2002). Therefore the isotope ratios must be partitioned among the possible sources (e.g., Koch and Phillips

[3] Carbon isotope turnover in the chiton of locusts (*Locusta migratoria* Linnaeus 1758; Orthoptera: Acrididae) can occur in as little as eight days (Webb *et al*. 1998).

2002, Phillips and Koch 2002, Phillips and Gregg 2003, Robbins *et al.* 2002). Thus, while isotope studies often result in new insights into trophic relationships, they rarely give completely decisive explanations of ecosystem functioning.

Stable isotopes of nitrogen and carbon have been used with some success to characterize food webs and trophic levels of a cave in Arkansas (Graening 2000), with sea cave-inhabiting fruit bats in Mexicoa (Ceballos 1997), in cave communities at Fort Hood, Texas (Taylor *et al*. 2004) and in anchialine aquatic cave communities in Mexico (Pohlman *et al*. 1997) and northwestern Australia (Humphreys 1999). In spite of a fairly substantive body of research on the biology of North American cave crickets (cited earlier, and see Lavoie *et al*. [2007]), there are no other studies of cave-inhabiting Rhaphidophoridae (*Ceuthophilus* spp., *Haedonoecus* spp., etc.) that have utilized stable isotope analyses.

Site Selection

During initial visits to potential field sites, we investigated numerous caves, finally selecting the following 9 caves for our study: Bonepile Cave and Surprise Sink (both in Government Canyon State Natural Area), Genesis Cave (San Antonio), Academy Cave (San Marcos), and five Austin caves: Lost Oasis Cave, Blowing Sink Cave, Driskill Cave, LaCross Cave, and Slaughter Creek Cave. These caves were selected to represent a variety of urban and rural settings (Table 1).

Levels of Human Impact

During the last field visit, we also characterized levels of human impact using aerial photography (Figure 1), examining an area of 11.2 acres (radius 120 meters from cave entrance), corresponding to the maximum foraging distance of *Ceuthophilus* (*C.*) *secretus* recorded by Taylor et al. 2004) and an area of 90 acres (radius of 340 meters), corresponding to some estimates of recommended karst preserve size. By overlaying a grid of points and scoring each point into one of several categories (Grass/Herb Natural; Yard/Flower Beds, etc.; Trees/Shrubs Natural; Trees/Shrubs Cultivated; Dirt/Gravel Road; Paved Road/Lot; Cement Sidewalk; Building/Structure; Bare Ground/Dirt Trails) which were then classified as Pervious/ Impervious and Natural/ Modified as in Figure 2.

These scorings which was verified and corrected (as needed) on the ground, and percentages Pervious/ Impervious and Natural/ Modified were then recorded. The 9 caves ended up falling out very nicely into three levels of human impact, allowing evaluation of in-cave counts of animal life in relation to levels of human impact.

Stable Isotopes

Stable isotope ($\delta^{13}C$ and $\delta^{15}N$) data were obtained from cave crickets and other organic constituents of the epigean and subterranean ecosystems at three urban, three `intermediate' and three rural cave sites (corresponding to high, medium and low human impact, see below) during each of the four seasons (spring, summer, fall, winter), with the exception of one cave which was missed during one sampling period.

We obtained samples of the dominant cave crickets (what we thought[4] to be *Ceuthophilus cunicularis*, *Ceuthophilus secretus* and *Ceuthophilus* species B), RIFA, a selection of the more common (visually dominant) plant taxa near the cave entrance, and other selected cavernicoles including millipeds (*Cambala speobia* (Chamberlin), *Speodesmus* sp.), spiders (*Cicurina varians* and other, non-endangered, *Cicurina* species]), springtails (mostly *Pseudosinella violenta*), harvestmen (*Lieobunum townsendii*) and a selection of other taxa from these nine caves. Federally listed endangered taxa were not sampled, and at some of the caves with higher levels of impact it was not feasible to obtain samples of all of the above taxa.

Methods for isotope analysis are almost the same as for Taylor *et al*. (2004), but are repeated here for clarity and convenience. Samples of invertebrates were collected and kept on dry ice for shipping to the laboratory in Illinois, where they were kept frozen until processed. For some taxa, multiple individuals were collected and pooled to obtain sufficient material for analysis, because individual biomass was low. Vegetative samples of abundant plant species were collected and cleaned of arthropods. Selected individuals of each taxon (plants and animals) were preserved as vouchers, and

[4] The taxonomy of the genus *Ceuthophilus* in Texas is presently unstable below the subgeneric level. Here we refer to *Ceuthophilus* (*Ceuthophilus*) *secretus* sensu lato, *Ceuthophilus* (*Geotettix*) *cunicularis* sensu lato, and *Ceuthophilus* (*Ceuthophilus*) species B as the animals generally recognized by current workers to belong to that undescribed species. These problems are discussed in Weckstein et al. (2007).

Table 1. List of sites studied in central Texas.

Cave Name	**County**	**Location**	**Landowner**	**Endangered Species?**	**Impact**
Surprise Sink	Bexar	Govt. Canyon State Natural Area	Texas Parks and Wildlife	yes	low
Lost Oasis Cave	Travis	South Austin	Texas Cave Management Association	no	medium
Bone Pile Cave	Bexar	Govt. Canyon State Natural Area	Texas Parks and Wildlife	yes	low
Blowing Sink Cave	Travis	Austin	City of Austin	no	low
Genesis Cave	Bexar	San Antonoio	A Church	yes	high
Academy Cave	Hays	San Marcos	Texas State University	no	high
Slaughter Creek Cave	Travis	SW of Austin	City of Austin	no	medium
Driskill Cave	Travis	South Austin	Texas Department of Transportation	no	high
Lacrosse Cave	Travis	SW of Austin	The University of Texas Austin	no	medium

identifications confirmed by an appropriate expert (SJT or JKK for most animals, Dr. Geoff Levin [INHS] for plants). Vouchers specimens will be deposited in the Illinois Natural History Survey herbarium (plants) and insect collection (arthropods). Non-voucher plant and animal samples were oven dried, ground, and submitted for isotope analysis.

Dried samples were analyzed for the composition of C and N isotopes. As appropriate, samples were divided into subsamples and the stable isotope compositions were determined for each subsample separately – the sample isotope composition is presented as the mean of the subsamples ± standard error. When sufficient resources were available, additional samples were obtained.

Nitrogen and carbon isotopes were measured using a Finnigan Mat 252 isotope ratio mass spectrometer (IRMS) with an attached Carlo Erba NC 2500 Elemental Analyzer (EA) with a ConFlo II Split Interface. Insect and plant samples were dried in an oven at 80 °C for at least 72 hours and ground using a mortar and pestle to homogenize the samples. Dried samples were stored in a desiccator until they could be weighed and analyzed for their carbon and nitrogen isotopic composition. Approximately 400-700 µg of the insect samples were used for the simultaneous nitrogen and carbon isotope analyses. Due to the low N-content, plant samples were analyzed separately for nitrogen (using ~1500 to 2700 µg of sample) and carbon (using ~500 µg of sample) isotope analysis. Samples were wrapped in tin capsules and combusted in the EA which was set at 1020°C. The N_2 and CO_2 gases released during combustion were separated by a gas chromatograph column and introduced into the IRMS for analysis through a capillary tube.

The isotopic composition is reported in the delta (δ) notation which compares the ratio of two isotopes of the same element in a sample to the same ratio in an internationally accepted standard. The delta notation is defined as:

$$\delta X = [(R_{smpl} - R_{std}) / R_{std}] \times 1000$$

Where X is the isotope of interest such as, ^{15}N or ^{13}C, and R is the ratio of the isotopes being analyzed; for N the ratio is $^{15}N/^{14}N$ and for C the ratio is $^{13}C/^{12}C$. Thus, the isotopic ratio in a sample is compared to the same ratio in the standard. The results are reported in parts per thousand or per mil (‰). If the sample contains a greater amount of the heavier isotopes compared to the standard, the delta value is positive, if there are less heavy isotopes in the sample compared to the standard, the δ value is negative.

The $\delta^{15}N$ and $\delta^{13}C$ values are reported relative to air and the Vienna Pee Dee Belemnite (V-PDB) international standards, respectively. The samples were measured against a laboratory reference standard which is calibrated to V-PDB through analysis of NBS-19 which has a $\delta^{13}C$ value -1.95 ‰ (Coplen, 1994). Reproducibility for both $\delta^{15}N$ and $\delta^{13}C$ is ± 0.15 and ± 0.25 ‰ based on multiple analyses of an internal standard with similar N and C concentrations as the samples run during this study.

Weight percents were calculated by comparing the measured peak area, sample weight, and a set peak area defined using a thiourea standard with 36.8 % nitrogen and 15.8 % carbon. The reproducibility of weight percents was ± 5 % of the total weight percent for the samples. Each sequence of samples was run with the following standards: three internal standards at the beginning, two in the middle, and two at the end of the run, and every tenth sample was run as a duplicate. A thiourea standard was used to set weight percent at the start of each run followed by another thiourea and a hydroxyproline to verify weight percents.

Nitrogen and carbon isotope compositions derived from the above procedures were then plotted on graphs, and the distribution of the data was used to assess potential trophic relationships among the taxa examined.

Cave Fauna Census

For all nine caves, we obtained four seasons of in-cave timed counts of animal life in the caves. During each of these visits, the field crew – usually two people – systematically moved through each cave counting all of the animals encountered. The nine caves are all relatively small (like many of the endangered species caves in the Austin/San Antonio area). For the largest of these caves (Blowing Sink [low impact], Genesis [high impact], and Surprise Sink [low impact]), we sampled only the areas of the caves closer to the entrance, including a portion of the dark zone comperable to the other cave.which made this approach feasible. For many of the taxa, fairly specific field identifications were possible because the field crew consisted of persons experienced in working with the biota of central Texas caves.

Census data were supplemented in a few cases with cricket exit counts. Crickets (*Ceuthophilus* spp.) were counted as they exited the caves during the two hours immediately following sunset. Observers sat quietly at the cave entrance, using red lights to count crickets as they exited the cave. Red lights minimize disturbance of natural cricket behavior, and white lights were available for searching areas that were too far away to see with red light.

Figure 1. Arial photograph in the vicinity of one of the caves with high levels of human impact.

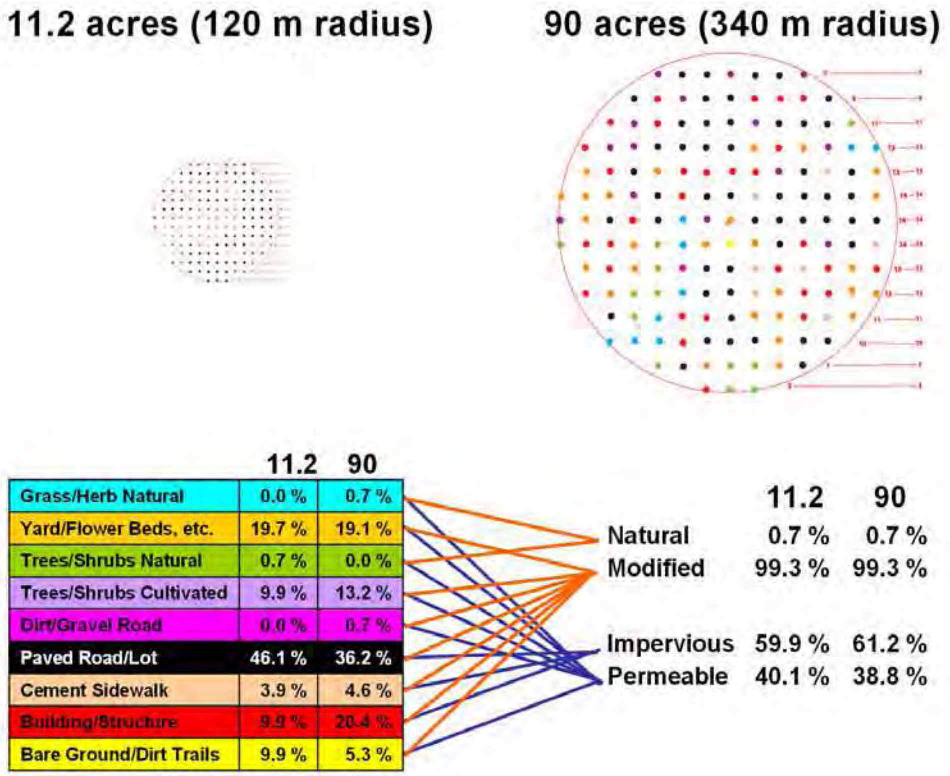

Figure 2. Categories used to score aerial photographs centered on each of the nine caves.

Results & Discussion

Levels of Human Impact

The nine caves selected a priori to represent three levels of human impact (low, medium, high) fit quite nicely in these categories, based both on percentage of impervious cover (Figure 3) and percentage of modified habitat (Figure 4) for both 11.2 acre (120 m radius) and 90 acre (340 m radius) circles overlaid on topographic maps. Detailed results of aerial photograph scoring are in Appendix A. Slaughter Creek Cave showed a lower level of human impact for the smaller area than the larger, because it is situated in a preserve bordered by development, and the larger area encompassed some of that development.

Stable Isotopes

After removing outliers, and specimens that did not yield useable results (low voltage, insufficient sample mass [especially for springtails], etc.) a total of 960 samples were available for analysis. Of these, 80 lacked good $\delta^{15}N$ data (primarily due to problems with obtaining sufficient mass of plants to get reliable N readings) and three lacked good $\delta^{13}C$ data, leaving 877 samples which could be plotted for both $\delta^{13}C$ and $\delta^{15}N$ (Appendix B).

Examining the general distribution of plant and animal isotope ratios (Figure 5), there appears to be a broad distribution of nitrogen isotopic ratios, indicating a variety of trophic levels are present in the dataset. Plants with different photosynthetic pathways are differentiated on the $\delta^{13}C$ axis, with C3 plants, comprising the majority of our samples, on the left and CAM (in the present study, only *Opuntia*) and C4 plants on the right. The distribution of the animal samples on both axes strongly suggests that the majority of the energy input into this ecosystem is from C3 plants, however, clearly there some utilization of the C4 and/or CAM plants. A few of the C3 plant samples, towards the upper right of Figure 5 (those above and to the right of a line running from $\delta^{13}C$ = -25, $\delta^{15}N$ = -0.5 to $\delta^{13}C$ = -28.5, $\delta^{15}N$ = 3.8), may have been contaminated with animal material even though an effort was made to clean off arthropods.

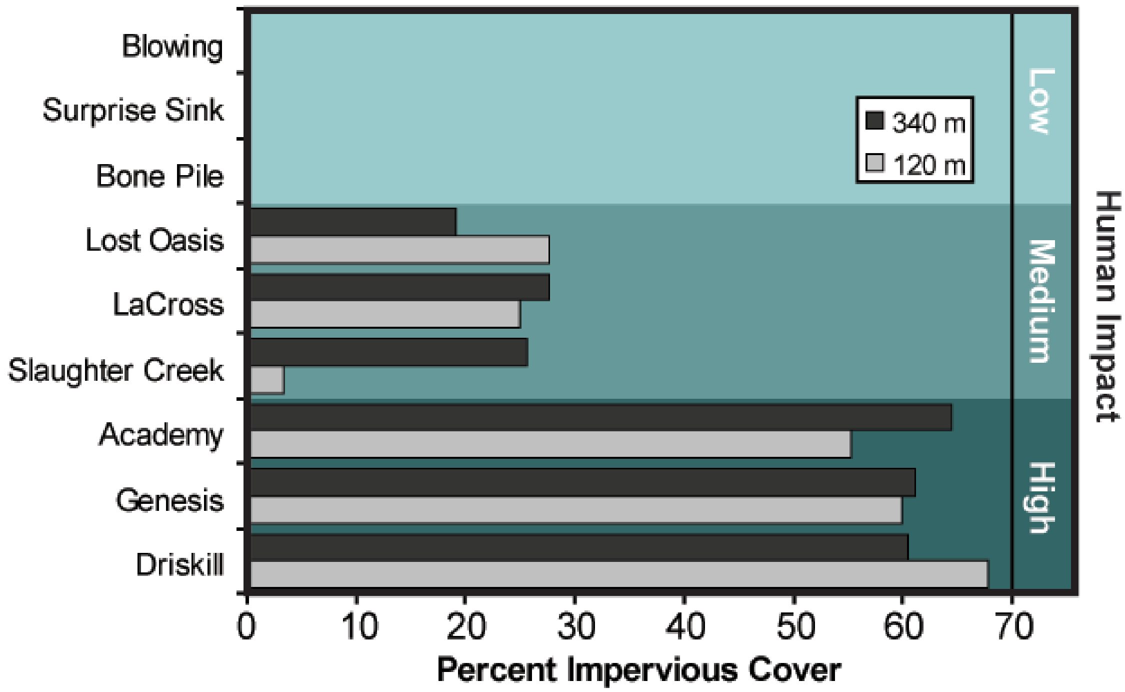

Figure 3. Percentage of impervious covered at each of nine Texas caves, based on scoring aerial photographs.

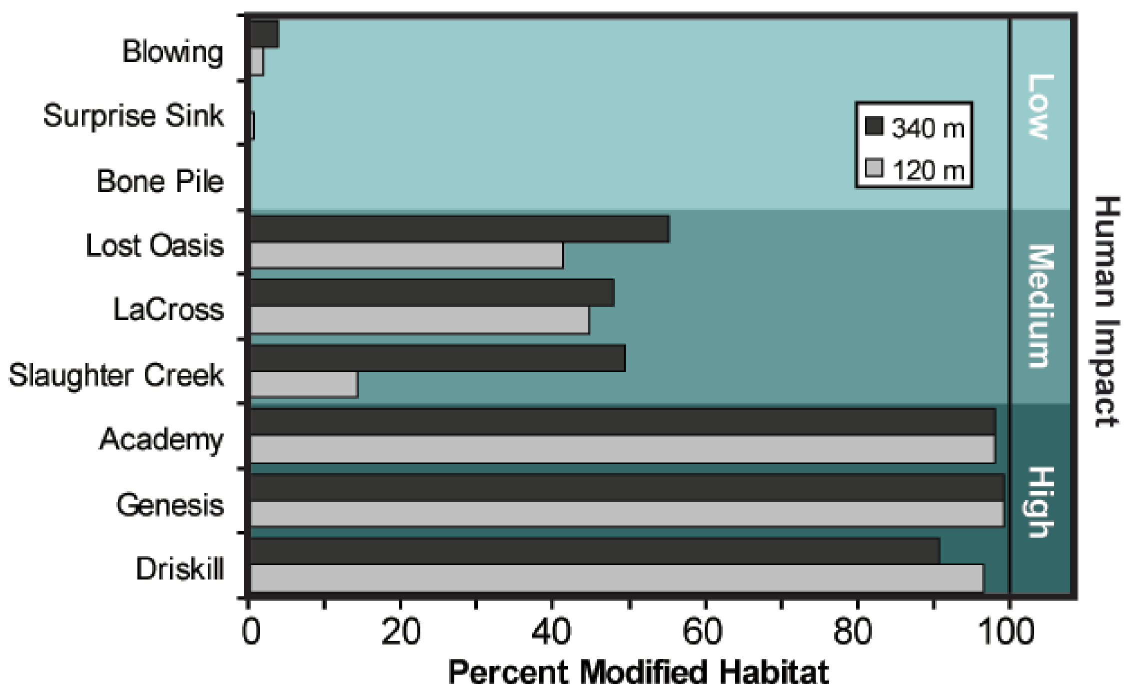

Figure 4. Percentage of modified at each of nine Texas caves, based on scoring aerial photographs.

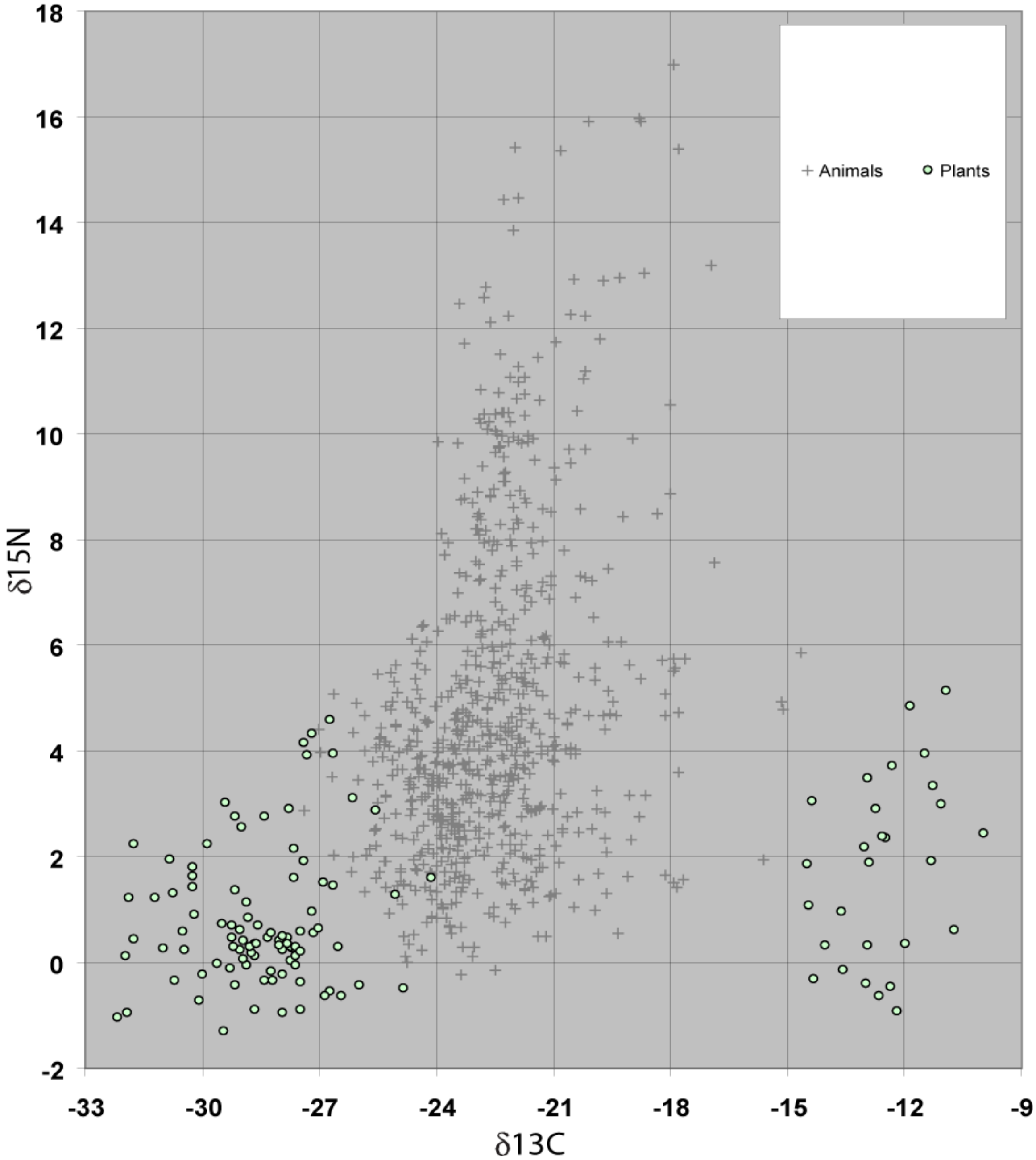

Figure 5. Carbon and Nitrogen isotope ratios for all samples from all sites. Gray crosses represent invertebrate samples. Plant samples (circles) are represented by C3 plants on the lower left, and C4 + CAM plants on the lower right.

When individual plant taxa are plotted (Figure 6), no obvious patter, beyond the photosynthetic pathway, is apparent, and therefore we pooled all plant taxa within photosynthetic pathways for the remaining analyses. Of the 35 visually dominant plant taxa recorded in this study (Table 2) the majority are native and non-invasive. None of the invasive or introduced taxa were recorded from the three sites with low levels of human impact (Bone Pile, Blowing Sink, and Surprise Sink caves) (Table 2). Taxa occurring dominantly at the greatest number of sites included Texas Persimmon (all 9 sites), Plateau Live Oak (7 sites), Algarita (6 sites), Ashe's Juniper (6 sites), Cedar Sedge (6 sites). Twenty of the plant taxa were considered visually dominant at only one site (Table 2).

Of the three *Ceuthophilus* (cave cricket) taxa (Figure 7), *Ceuthophilus* (*Geotettix*) *cunicularis* appears to generally be carnivorus, occurring higher up on the $\delta^{15}N$ than the other two taxa, *Ceuthophilus* (*Ceuthophilus*) *secretus* and *Ceuthophilus* (*Ceuthophilus*) species B. These latter two species appear to be primarily herbivorous, with few differences between the species. The range of values for *C*. (*C*.) species B falls within the range of values for *C*. (*C*.) *secretus*, but *C*. (*C*.) *secretus* has a slightly stronger affinity for C3 plants than *C*. (*C*.) species B. The range of trophic levels for *C*. (*G*.) *cunicularis* is rather broad, and it is unclear whether some of the more extreme data points represent erroneous data, or if, instead, this species feeds broadly across trophic levels, with prey ranging from primary producers to scavengers and predators. The common harvestman *Leiobunum townsendii* also appears to be primarily herbivorous, and occupies a narrow range of $\delta^{13}C$ valuesin an area generally to the left of the two *Ceuthophilus* taxa in the subgenus *Ceuthophilus* in the stable isotope plot (Figure 8), indicating they probably rely on a narrower range of food sources than do the two herbivorous *Ceuthophilus* species. Unidentified harvestmen appear to belong to *L. townsendii*. Overall, the two *Ceuthophilus* subgenera and *L. townsendii* tended to occupy differing trophic positions (Table 3), and *C. secretus* and *C*. species B feed at the same trophic level.

Spiders identified as *Cicurina* sp. are small pale or eyeless taxa, but occasionally include immature *Cicurina varians* specimens which were not identified to species level. Both *Cicurina* sp. and *Cicurina varians* are clearly top predators in the cave ecosystems

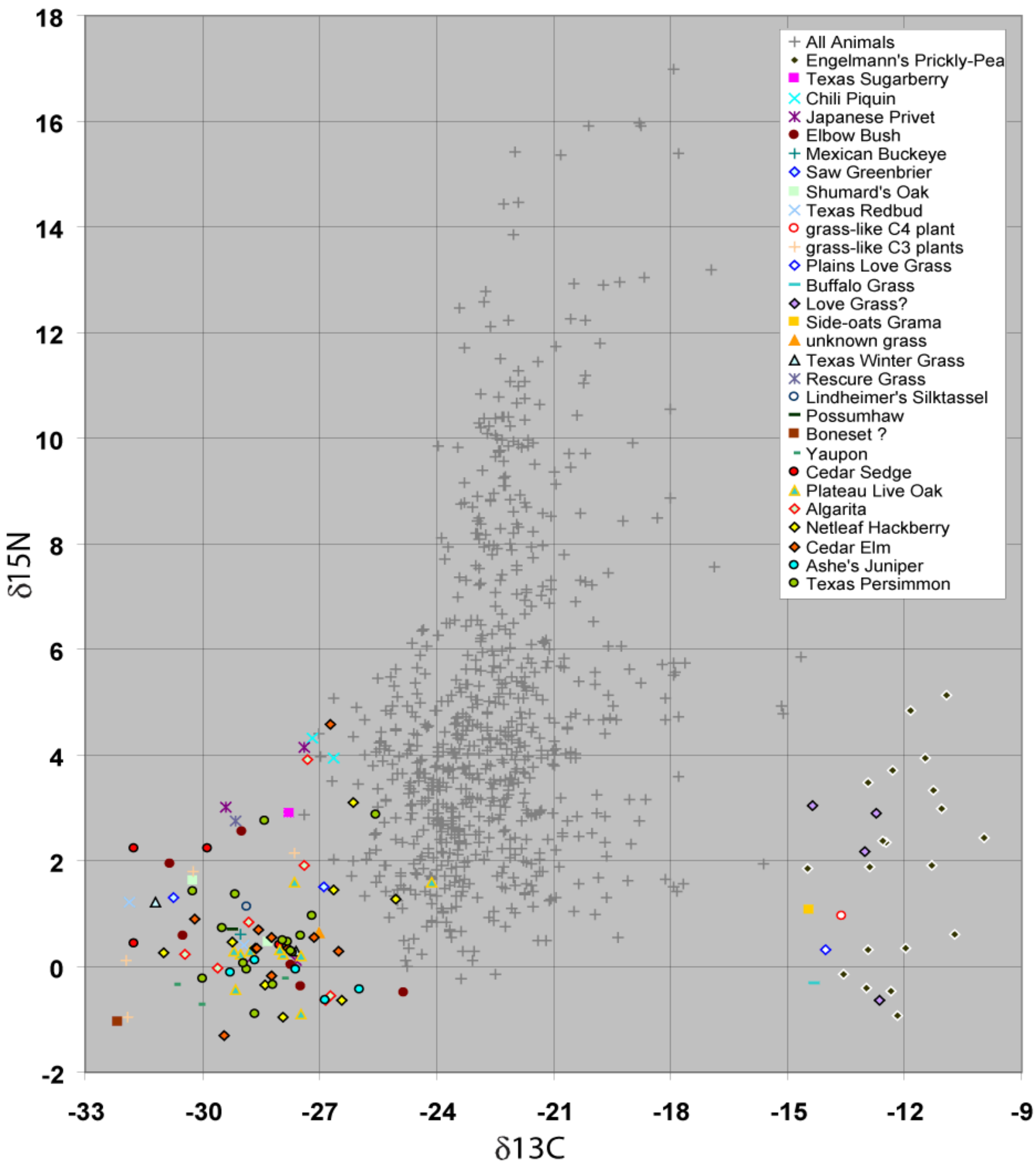

Figure 6. Carbon and Nitrogen isotope ratios for all samples from all sites, with individual plant taxa identified (see Table 2 for scientific names).

Table 2. Visually dominant plant taxa recorded from each site. Nativity and invasiveness based on Levin and Taylor (2007).

Family	Common Name	Scientific Name	Native	Invasive	Academy	Blowing	Bonepile	Driskill	Genesis	LaCrosse	LostOasis	Slaughter	Surprise
Poaceae	Buffalo Grass	*Buchloe dactyloides* (Nutt.) Engelm.	Y	Y	.	.	.	.	.	.	+	.	.
Poaceae	Rescue Grass	*Bromus catharticus* Vahl	N	Y	+	.	.	.	.	.	.	.	.
Poaceae	Bermuda Grass	*Cynodon dactylon* (L.) Pers.	N	Y	+	.	.	.	.	.	.	.	.
Aquifoliaceae	Possumhaw	*Ilex decidua* Walter	Y	N	.	.	.	+	.	.	.	.	.
Aquifoliaceae	Yaupon	*Ilex vomitoria* Sol.	Y	N	.	+	.	.	.	.	.	+	.
Berberidaceae	Algarita	*Berberis trifoliolata* Moric.	Y	N	+	.	.	+	+	+	.	+	+
Boraginaceae	Anacua, Sugarberry	*Ehretia anacua* (Terán & Berl.) I.M. Johnston	Y	N	+	.	.	.	.	.	.	.	.
Cactaceae	Engelmann's Prickly-Pear	*Opuntia cf. phaecantha* Engelm.	Y	N	.	.	.	.	+	.	.	.	.
Cupressaceae	Ashe's juniper	*Juniperus ashei* J. Buchholz	Y	N	.	+	+	+	.	.	+	+	+
Cyperaceae	Cedar sedge	*Carex planostachys* Kuntze	Y	N	+	+	.	.	+	+	.	+	+
Ebenaceae	Texas Persimmon	*Diospyros texana* Scheele	Y	N	+	+	+	+	+	+	+	+	+
Fabaceae	Texas Redbud	*Cercis canadensis* L. var. *texensis* (S. Wats.) M. Hopkins	Y	N	.	.	+	.	.	.	.	.	.
Fagaceae	Plateau Live Oak	*Quercus fusiformis* Small	Y	N	.	.	.	+	+	+	+	+	+
Fagaceae	Shumard's Oak	*Quercus shumardii* Buckley	Y	N	.	.	+	.	.	.	.	.	.
Garryaceae	Lindheimer's Silktassel	*Garrya ovata* Benth. subsp. *lindheimeri* (Torr.) Dahling	Y	N	.	.	+	.	.	.	.	.	.
Moraceae	Texas Mulberry	*Morus microphylla* Buckley	Y	N	.	.	.	.	.	.	.	.	+
Oleaceae	Spring-Herald, Elbow-Bush, Stretchberry	*Forestiera pubescens* Nutt. var. *pubescens*	Y	N	.	+	.	+	.	.	.	.	+
Poaceae	Side-oats Grama	*Bouteloua curtipendula* (Michx.) Torr.	Y	N	.	.	.	+	.	.	.	.	.

(continued on following page)

Table 2. (concluded).

Family	**Common Name**	**Scientific Name**	**Native**	**Invasive**	**Academy**	**Blowing**	**Bonepile**	**Driskill**	**Genesis**	**LaCrosse**	**LostOasis**	**Slaughter**	**Surprise**
Poaceae	Texas Grama	*Bouteloua rigidiseta* (Steud.) A.S. Hitchc.	Y	N	.	.	.	.	.	+	.	.	.
Poaceae	Virginia Wild Rye	*Elymus virginicus* L.	Y	N	.	.	.	.	.	.	+	.	.
Poaceae	Plains Love Grass	*Eragrostis intermedia* Hitchc.	Y	N	.	.	+	.	.	.	.	.	.
Poaceae	Texas Winter Grass	*Nassella leucotricha* (Trin. & Rupr.) Barkworth	Y	N	.	+	.	.	.	+	+	.	.
Poaceae	Needleleaf Rosette Grass	*Panicum cf. aciculare* Desv. ex Poir.	Y	N	.	.	.	+	.	.	.	.	.
Sapindaceae	Mexican-Buckeye	*Ungnadia speciosa* Endl.	Y	N	.	.	+	.	.	.	.	.	.
Smilacaceae	Saw Greenbrier	*Smilax bona-nox* L.	Y	N	.	.	+	.	.	+	+	.	.
Solanaceae	Chilitepin, Chile Piquin, Bird Pepper	*Capsicum annuum* L. var. *glabriusculum* (Dunal) Heiser & Pickersgill	Y	N	+	.	.	.	.	.	.	.	.
Ulmaceae	Netleaf Hackberry	*Celtis laevigata* Willd. var. *reticulata (*Torr.) L. Benson	Y	N	.	+	.	+	+	.	+	.	.
Ulmaceae	Texas Sugarberry	*Celtis laevigata* Willd. var. *texana* (Scheele) Sarg.	Y	N	+	.	.	.	.	+	.	.	.
Ulmaceae	Cedar Elm	*Ulmus crassifolia* Nutt.	Y	N	+	+	.	+	.	+	.	+	.
Oleaceae	Japanese Privet	*Ligustrum japonicum* Thunb.	N	N	+	.	.	+	.	.	.	.	.
Poaceae	King Ranch Bluestem	*Bothriochloa ischaemum* (L.) Keng var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celarier & Harlan	N	N	.	.	.	.	.	.	.	+	.
Poaceae	King Ranch Bluestem	*cf. Bothriochloa ischaemum* (L.) Keng	N	N	.	.	.	.	+	.	.	.	.
Asteraceae?	Boneset?	*Eupatorium* ?	.	.	.	.	+	.	.	.	.	.	.
Poaceae	Love Grass?	*cf. Eragrostis*	.	.	.	.	.	+	+	+	.	.	+
Poaceae	Unknown grass	unidentified Poaceae	.	.	.	.	+	.	.	.	+	.	.

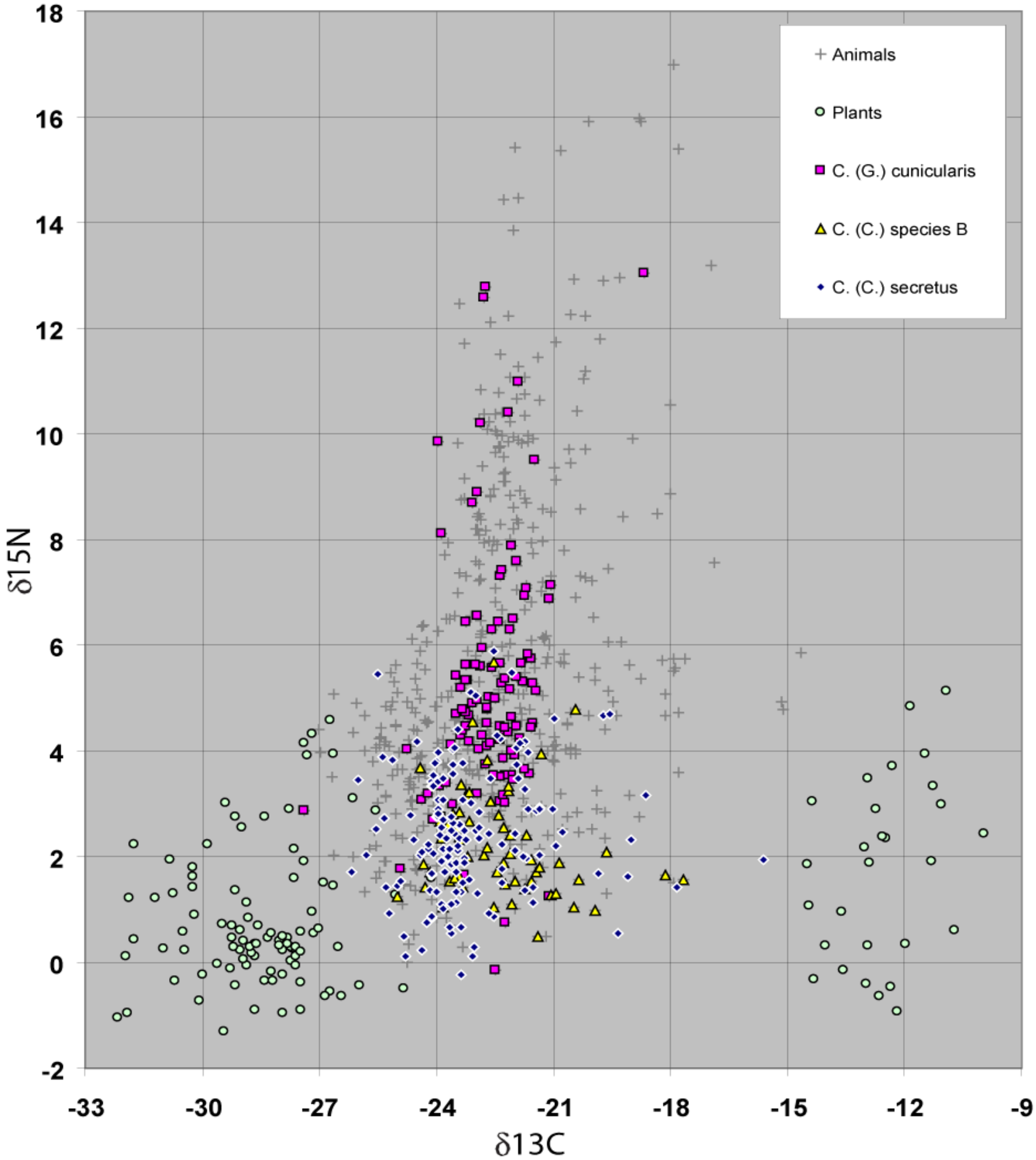

Figure 7. Carbon and Nitrogen isotope ratios for all samples from all sites, with *Ceuthophilus* taxa highlighted.

Table 3. Summary of statistical tests comparing trophic position ofcave crickets and harvestmen. Means with the same letter below them are not significantly different in *post hoc* multiple comparisons (Tukey's), *post hoc* test not given for non-significant overall tests. sig.=level of significance, ns=not significant, *=significant at α=0.05, **=significant at α =0.01, ***=significant at α =0.001.

Isotope Ratio	Taxon (n, Mean±Standard Error) *C. cunicularis*	*C. secretus*	*C.* species B	*L. townsendii*	df	F	P	sig.
$\delta^{13}C$	105, -22.61±0.0967 A	143, -23.11±0.134	62, -22.424±0.184 A	62, -24.799±0.094	3,368	45.12	<0.0001	***
$\delta^{15}N$	105, 5.20±0.229	143, 2.453±0.102 A	62, 2.264±0.127 A	63, 3.452±0.183	3,369	69.42	<0.0001	***

of central Texas caves, occurring higher on the $\delta^{15}N$ axis than any of the other taxa, feeding at a higher trophic level than *C*. (*C*.) *secretus* and *C*. (*C*.) species B, and most commonly occurring higher on the $\delta^{15}N$ axis than *C*. (*G*.) *cunicularis*. Several unidentified spiders and the scorpion *Pseudouroctonus reddelli* (a common troglophile) also have isotopic signatures typical of predators (Figure 8).

Two genera of millipeds commonly occur in central Texas caves, and these are often most abundant in association with *Ceuthophilus* spp. guano (Taylor et al. 2003). Specimens of the genus *Cambala*, most if not all of which belong to the species *Cambala speobia* (Chamberlin) (Figure 9), were common, and appear to be feeding at a trophic level that is consistent with a cave cricket guanophile (Figure 10). The other common milliped, *Speodesmus*, falls out somewhat to the right of the *Cambala* on the $\delta^{13}C$ axis, suggesting more of an association with C4 or CAM plant pathways. The trophic position of these two milliped taxa also is consistent with feeding on the guano of *L. townsendii* (Figure 8).

Two terrestrial isopod taxa were encountered in the caves, the facultatively troglophilic *Porcellio* sp. isopods, which apparently function as high-level predators in the caves (Figure 11), at a level similar to *Cicurina* spp. The more cave-adapted *Brackenridgia* sp. isopods, also function at a fairly high tropic level (Figure 11), somewhat higher, on average, than *C*. (*G*.) *cunicularis*. *C*. (*G*.) *cunicularis* and *Brackenridgia* sp. likely feed by scavenging, hunting, and as guanophiles in association with the guano deposits of the surface-foraging *Ceuthophilus* species. Unidentified isopods are attributable to *Brackenridgia* sp., based on their trophic position.

Among the remaining taxa analyzed for carbon and nitrogen isotopes, the red imported fire ant, *S. invicta*, stands out in two ways (Figure 12). First, it appears generally to be feeding at a level typical of carnivores, scavengers and omnivores, and certainly functioning at a higher trophic level than the crickets *C*. (*C*.) *secretus* and *C*. (*C*.) species B (Figure 7). Second, *S. invicta* is rather broadly distributed on the $\delta^{13}C$ axis, suggesting a stronger association with the C4 and CAM photosynthetic pathways than is typical of the members of the cave community. These data suggest that RIFA is not competing with surface foraging *Ceuthophilus* species for plant materials (because

Figure 8. Carbon and Nitrogen isotope ratios for all samples from all sites, with arachnid taxa highlighted.

Figure 9. *Cambala speobia* (Chamberlin) on fecal pellets of *Ceuthophilus* spp. in Surprise Sink, Bexar County, Texas. A small springtail, *Pseudosinella violenta*, can be seen to the right of the center of the image. Photo by Jean K. Krejca.

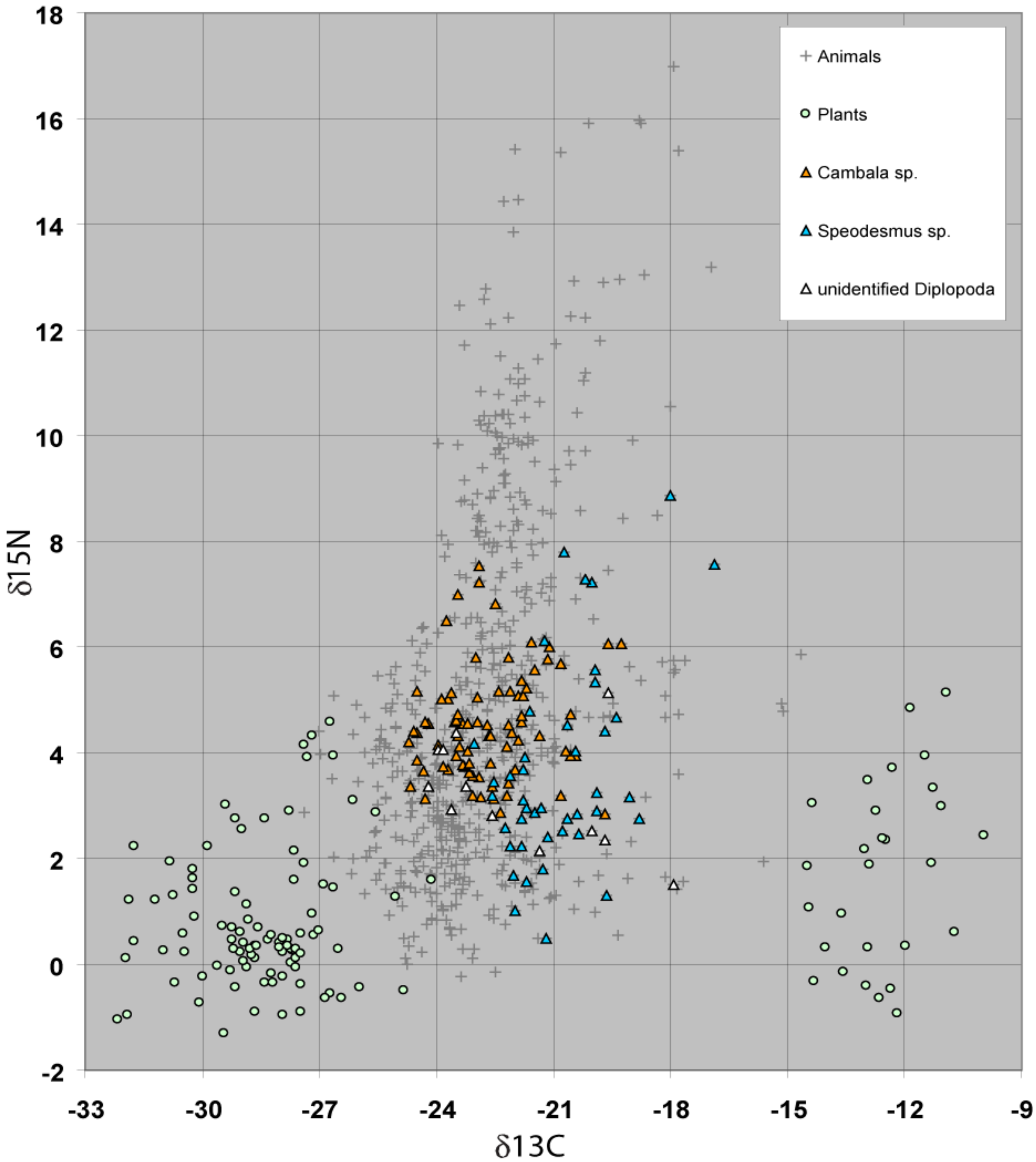

Figure 10. Carbon and Nitrogen isotope ratios for all samples from all sites, with milliped taxa highlighted.

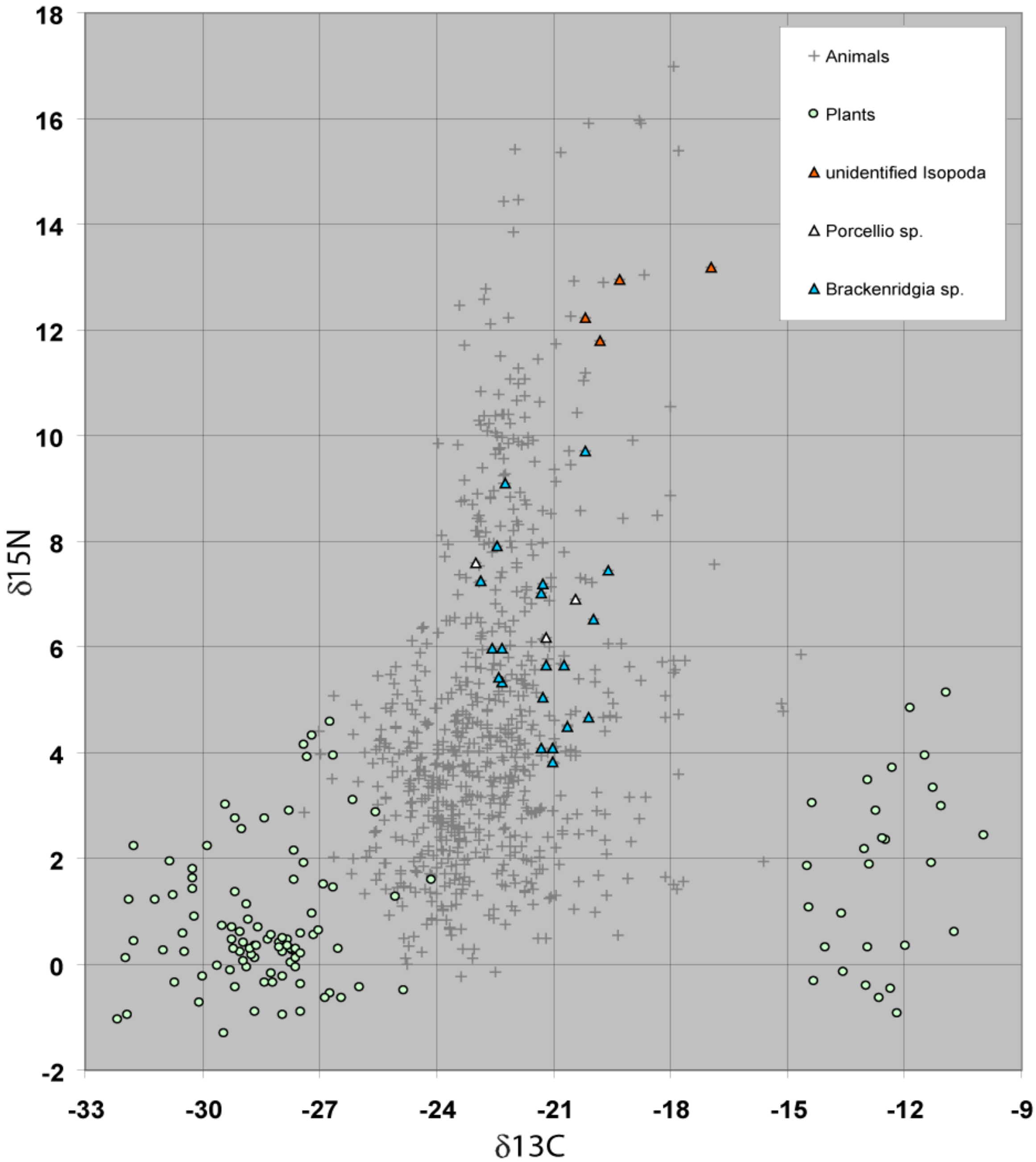

Figure 11. Carbon and Nitrogen isotope ratios for all samples from all sites, with isopod taxa highlighted.

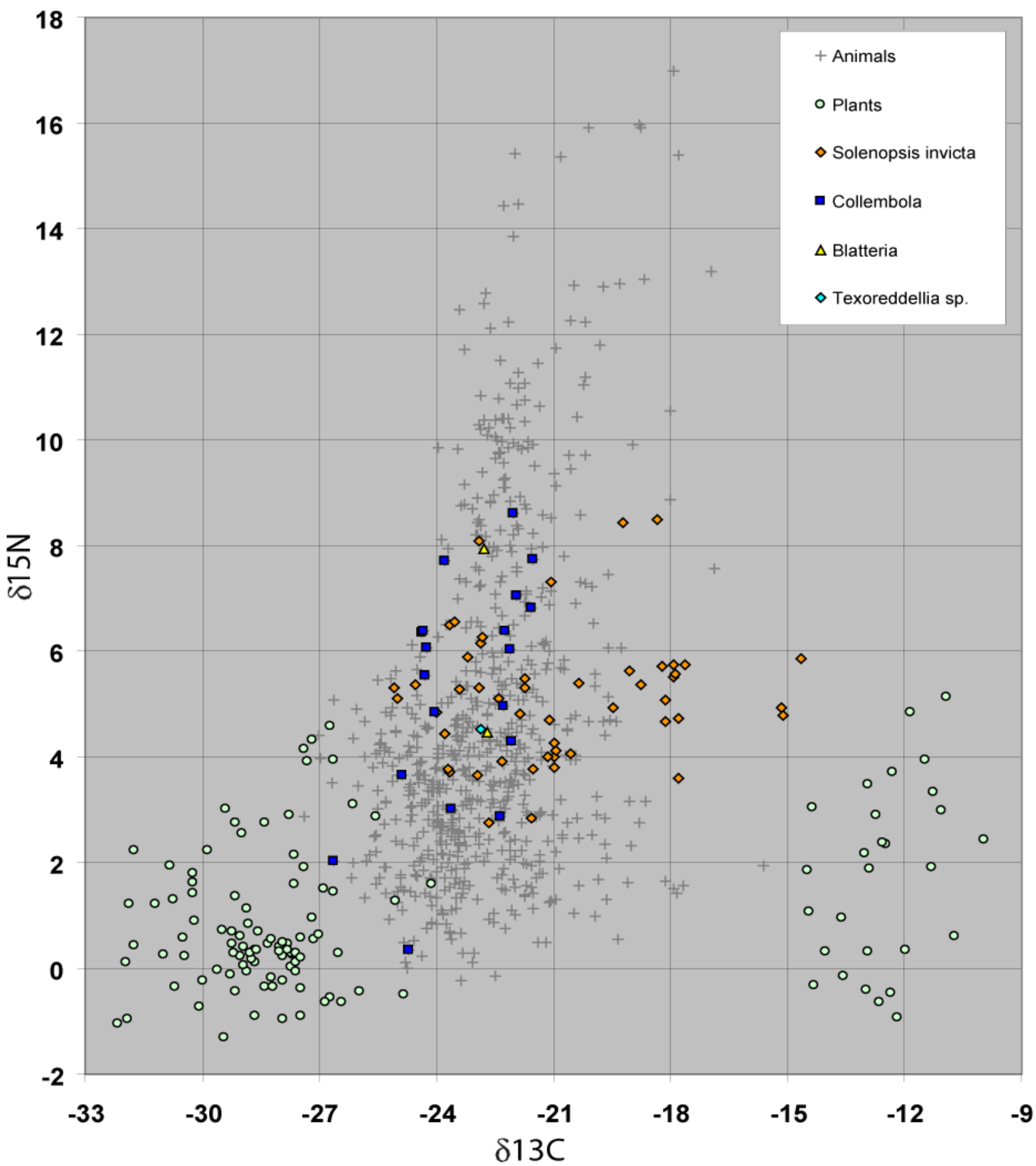

Figure 12. Carbon and Nitrogen isotope ratios for all samples from all sites, with fire ants, springtails, cockroaches, and bristletail highlighted.

the crickets are feeding at a lower trophic level), although we know that it does compete with *C.* (*C.*) *secretus* at bait stations (Taylor et al. 2003, Helf 2005), prey upon cavernicoles, and feed on *C.* (*C.*) *secretus* (e.g., Taylor et al. 2003 [see cover photo of that report]).

The springtails recorded in this study mostly belong to the species *Pseudosinella violenta* (Figure 13). Due to their small size, we commonly had trouble with isotopic analysis of springtails, and we believe the distribution of sample values includes much more error than for most other samples. Many of the springtails came out somewhat high on the δ^{15}N axis than expected (Figure 12), and this may be the result of problems in the detection of the isotopes in samples with very little mass. These animals are freaquently found in association with cricket guano, and association with guano might cause them to plot relatively high on the δ^{15}N axis – guano of many animals contains considerable quantieis of N, much of this being present as ammonia, which would have a tendency to evaporate (though perhaps not so readily in the cave environment), increasing the δ^{15}N of the remaining material. Vertebrate manure ranges from about +8 to +25 ‰ (Clark and Fritz 1997, Kendall 1998), but we are not aware of similar studies for herbivorous arthropod guano. Finally, if some of the guano on which the collembolan are feeding is bat guano, we might expect still higher δ^{15}N values, as bats are insectivorous. For bats in particular, Graening and Brown (2001) found guano isotopic values ranging from +9 to +14.2 ‰. Similarly, if there is guano from other animals in the caves (*Peromyscus*, etc.) we might expect individual isotopic signatures of springtail samples to be somewhat variable due to the varied sources.

Ignoring the less common taxa and focusing just on the numerically more abundant taxa, a general sense of the trophic structure can be obtained by evaluating mean values for δ^{13}C and δ^{15}N with standard deviations providing a sense of variability (Figure 14). This view (Figure 14) allows us to estimate the distance between trophic levels on a per mil (‰) basis. The generally accepted distance between trophic levels is about 3.4 ‰ on the δ^{15}N axis (Michener and Schell 1994, Wada *et al*. 1991). However, it appears (Figure 14) that C. secretus and C. species B are only about 1.50 to 1.68 ‰ above the mean value of C3 plants on the δ^{15}N axis. This problematic

Figure 13. *Pseudosinella violenta* in association with Ceuthophilus guano and fungi on the guano in Surprise Sink, Bexar County, Texas. Photo by Jean K. Krejca.

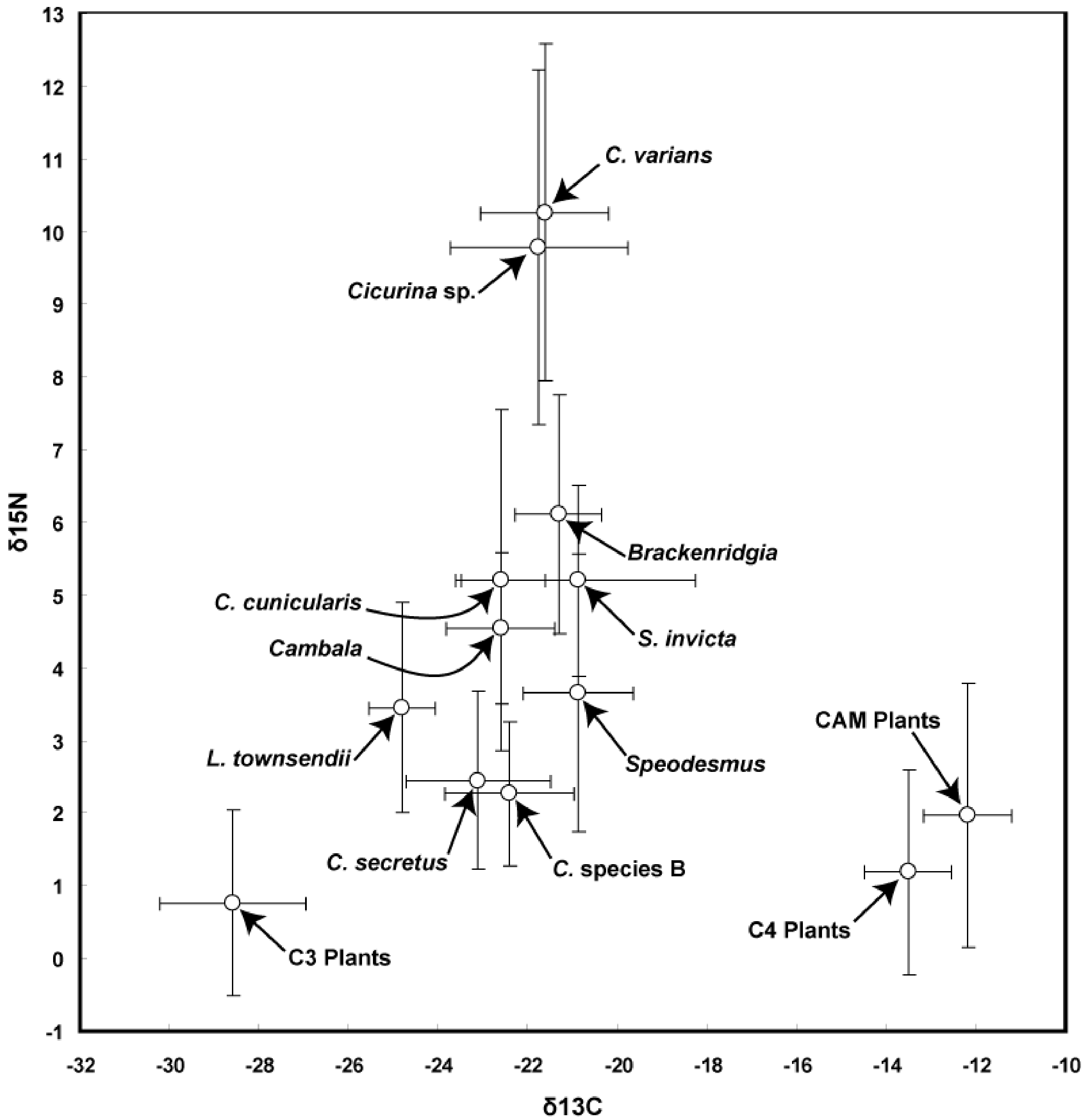

Figure 14. General summary of trophic structure of plants and cave macroinvertebrates in small central Texas caves. Points are mean values, error bars are standard deviations. Less frequently encountered taxa are omitted for clarity.

situation may be accounted for in part by the capacity for C. secretus to store food in their crop. We did not dissect out the digestive tract of the animals before drying and grinding the specimens – this could account for part of the discrepancy. In addition, it is possible that some of the C3 plant samples were not cleaned sufficiently (to remove phytophygous insects) which could result in their position moving up on the on the $\delta^{15}N$ axis, bringing them closer to the two cricket taxa. The distance between the more predatory *C. cunicularis* and the herbivorous *Ceuthophilus* taxa is only about 2.75 ‰ on the $\delta^{15}N$ axis (Figure 14), perhaps suggesting that *C. cunicularis* takes in a mix of plant and animal material. As can be clearly seen in Figure 5, assigning taxa to specific trophic levels is merely a convenience for understanding the trophic structure of the community – in fact, there is a continuum of trophic levels among individual animals. The failure to meet the expected ~3.4 ‰ stepwise enrichment by trophic level is not necessarily, however, indicative of a problem in the dataset or sample pricessing – Scrimgeour *et al*. (1995) and Scheu (2002) suggested that these values are not so clearly applicable to invertebrates, and the presence of mycoflora (e.g., Benoit *et al*. 2004, Stephenson *et al*. 2007) or microbial nitrogen fixation (Nardi *et al*. 2002) could explain much of the deviation from the classic 3.4 ‰ differentiation among trophic levels. See also discussion above under springtails.

We coded isotope samples by level of human impact (low, medium, high) to assess possible differences in isotopic composition based on level of impact (Figure 15). Somewhat surprisingly, the samples from low, medium, and high impact sites had significantly different values of $\delta^{15}N$, with low impact sites having lower values for $\delta^{15}N$ for animals in general (Table 4). The lowest animal $\delta^{15}N$ values (*Ceuthophilus* spp., and *L. townsendii*) occured at the low impact sites. Additionally, the top predators at the low impact sites had lower maximum $\delta^{15}N$ values than did those at the medium and high impact sites (Figure 15). In addition, animal samples, collectively, differed in $\delta^{13}C$ values between the three levels of impact (Table 4), with all pairwise comparisons between impact levels differing. Mean values for $\delta^{13}C$ were lowest (closest to the C3 plants) in the low impact samples, and highest (closer to the C4 and CAM plants) at the high impact sites. It is possible that soil conditions at the individual sites just happened

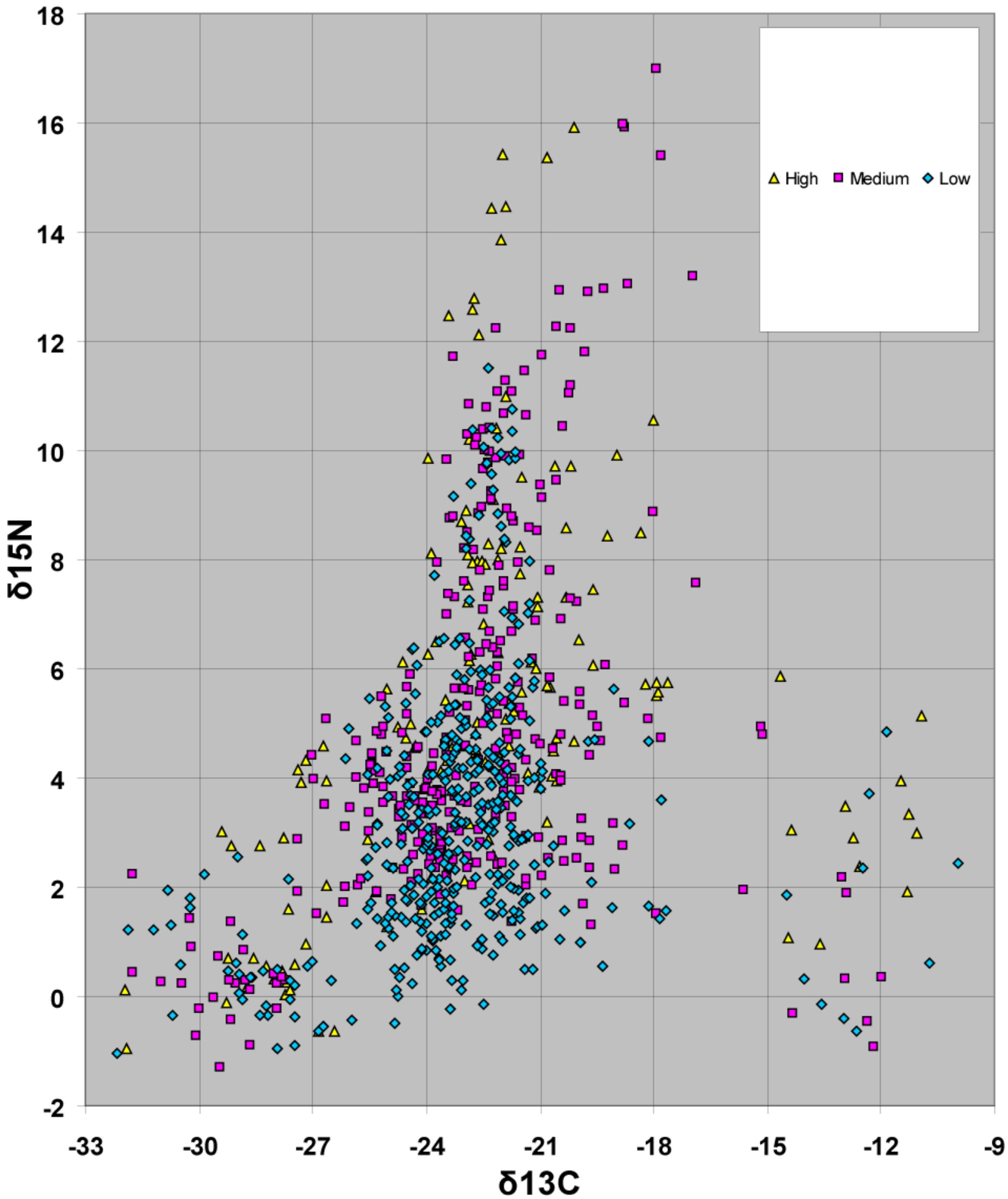

Figure 15. Carbon and Nitrogen isotope ratios for all samples from all sites, coded by level of human impact.

Table 4. Summary of statistical tests (one-way ANOVA) comparing samples from low, medium and high impact sites. Only taxa, or groups of taxa, with sufficient sample size for statistical analysis are shown. Means with the same letter below them are not significantly different in *post hoc* multiple comparisons (Tukey's), *post hoc* test not given for non-significant overall tests. sig.=level of significance, ns=not significant, *=significant at α=0.05, **=significant at α =0.01, ***=significant at α =0.001.

Sample Type	Isotope Ratio	Level of Impact (n, Mean±Standard Error) Low	Medium	High	df	F	P	sig.
All Animals	$\delta^{13}C$	368, -22.89±0.085	310, -22.48±0.119	112, -21.86±0.172	2,787	14.20	<0.0001	***
	$\delta^{15}N$	364, 3.62±0.122	290, 5.43±0.183	103, 6.88±0.310	2,754	69.84	<0.0001	***
All Plants	$\delta^{13}C$	59, -25.08±0.810	55, -25.30±0.988	53, -23.79±0.951	2,164	0.72	0.4883	ns
	$\delta^{15}N$	48, 0.65±0.179 A	34, 0.48±0.171 A	41, 1.82±0.257	2,120	12.15	<0.0001	***
C3 Plants	$\delta^{13}C$	46, -28.61±0.237 A	42, -29.27±0.228 B	39, -27.81±0.242 A B	2,124	9.13	0.0002	***
	$\delta^{15}N$	38, 0.43±0.151 A	27, 0.49±0.186 A	30, 1.46±0.300	2,92	7.09	0.0014	**
C. cunicularis	$\delta^{13}C$	62, -22.68±0.099	26, -22.42±0.285	17, -22.66±0.198	2,102	0.63	0.5334	ns
C. cunicularis	$\delta^{15}N$	62, 4.04±0.157	26, 6.02±0.388	17, 8.18±0.688	2,102	40.03	<0.0001	***

(continued on following page)

Table 4. Continued.

Sample Type	**Isotope Ratio**	**Level of Impact (n, Mean±Standard Error) Low**	**Medium**	**High**	**df**	**F**	**P**	**sig.**
C. secretus	$\delta^{13}C$	83, -23.18±0.166	58, -23.00±0.231	2, -22.87±0.439	2,140	0.23	0.7932	ns
C. secretus	$\delta^{15}N$	83, 2.09±0.146 A	58, 2.92±0.107 A	2, 4.03±0.257	2,140	10.78	<0.0001	***
Cambala	$\delta^{13}C$	31, -23.05±0.169 A	24, -22.67±0.288 A B	28, -22.06±0.217 B	2,80	5.35	0.006	**
Cambala	$\delta^{15}N$	29, 4.19±0.152 A	24, 4.48±0.190 A B	28, 5.01±0.244 B	2,75	4.53	0.0139	*
Cicurina sp.	$\delta^{13}C$	25, -21.77±0.593	33, -21.82±0.190	13, -21.57±0.395	2,68	0.08	0.9262	ns
Cicurina sp.	$\delta^{15}N$	22, 8.87±0.359 A	30, 9.41±0.353 A	12, 12.36±0.891	2,61	11.46	<0.0001	***
C. varians	$\delta^{13}C$	5, -22.22±0.343	25, -21.62±0.306	7, -21.24±0.512	2,34	0.68	0.5140	ns
C. varians	$\delta^{15}N$	5, 9.48±0.454	25, 10.88±0.508	7, 8.63±0.317	2,34	3.25	0.0511	ns

(continued on following page)

Table 4. Continued.

Sample Type	**Isotope Ratio**	**Level of Impact (n, Mean±Standard Error)** Low	Medium	High	**df**	**F**	**P**	**sig.**
L. townsendii	$\delta^{13}C$	27, -24.67±0.108	30, -24.96±0.163	5, -24.55±0.186	2,59	1.42	0.2503	ns
L. townsendii	$\delta^{15}N$	28, 2.46±0.255	30, 4.02±0.149	5, 5.58±0.281	2,60	25.83	<0.0001	***
S. invicta	$\delta^{13}C$	23, -22.08, 0.411 A	15, -20.26, 0.736 A B	13, -19.46±0.708 B	2,48	5.62	0.0064	**
S. invicta	$\delta^{15}N$	23, 4.69, 0.217 A	15, 4.65, 0.150 A	13, 6.72, 0.344	2,48	20.63	<0.0001	***
Speodesmus	$\delta^{13}C$	19, -21.75±0.122 A	25, -20.14±0.236 B	2, -21.74±0.501 A B	2,43	16.41	<0.0001	***
Speodesmus	$\delta^{15}N$	19, 2.51±0.212 A	22, 4.57±0.436 A	2, 4.35±1.768	2,40	8.11	0.0011	**

to differ in a manner that would yield these results, but it is more likely that some other factor is responsible for the observed differences. Unfortunately the study design, which serves well for looking at differences among impact levels, does not allow us to assess variability in isotopic values among sites within a level of impact.

While these effects are not so visually apparent in plant samples in Figure 15, we did find statistically significant differences between the three impact levels for plants (all taxa pooled) for $\delta^{15}N$ (Table 4), with *post hoc* multiple comparisons showing no difference between low and medium impact levels, but significant differences between all other pairwise comparisons. However, similar effect was not found for $\delta^{13}C$ values of plants in general (Table 4). The observed differences in plant $\delta^{15}N$ levels, which seem to trickle up the trophic levels for various taxa for which we has sufficient sample size to make comparisons among the three levels of impact (Table 4), could be attributable to differences in vegetative community structure – but this would also be a measure of human impact (that is, most of the remaining vegetation in the high impact sites is comprised of cultivated plants, mowed grass, etc.). These data, then, collectively suggest there are very real differences among the sites, and probably among the levels of impact, in the flow of nutrients through the cave ecosystems.

Cave Fauna Census

Cave fauna census data (Table 5) were collected as a part of the field work, although the timing did not always coincide with the seasonal sampling for isotopes (Table 6). Cave crickets (Ceuthophilus spp.) were by far the most abundant taxa, especially in low human impact caves, where as many as 2,900 individuals of *C*. (*C*.) *secretus* were counted in a single visit to Surprise Sink in August 2006 (Figure 16). High numbers of this species were also recorded during exit counts at medium and low human impact caves (Table 7). Few *C*. (*C*.) species B and no *C*. (*G*.) *cunicularis* were recorded exiting the caves during these counts.

In perhaps the most remarkable finding of this study, we found that not only were numbers of individuals of *Ceuthophilus* spp. fairly well correlated with the level of human impact, but that the total numbers of individuals of other taxa recorded from the caves

Table 5. Summary of timed census data for nine central Texas caves over four seasons.

Common Name	Scientific Name	Adaptation	Academy	Blowing Sink	Bonepile	Driskill	Genesis	LaCrosse	Lost Oasis	Slaughter Creek	Surprise Sink
cave cricket	*Ceuthophilus secretus*	TX	0	137	2122	2	2	39	284	483	3220
cave cricket	*Ceuthophilus cunicularis*	TB?	9	36	161	3	3	26	24	13	212
cave cricket	*Ceuthophilus sp. B*	TX	0	0	76	0	1	20	0	2	171
harvestman	*Leiobunum townsendii*	fTX	0	1080	552	0	0	62	94	415	453
harvestman	*Texella reyesi*	TB	0	0	0	0	0	0	0	0	0
harvestman	*Chinquipellobunus madlae*	TB	0	0	0	0	2	0	0	0	7
ground beetle	*Rhadine exilis*	TB	0	0	2	0	0	0	0	0	1
ground beetle	*Rhadine howdeni*	TP	0	0	0	0	0	0	0	0	2
ground beetle	*Rhadine infernalis*	TB	0	0	2	0	0	0	0	0	2
ground beetle	*Rhadine noctivaga*	TB	0	0	0	0	0	0	0	0	1
ground beetle	*Rhadine persphone*	TB	0	0	3	0	0	0	0	0	0
ground beetle	*Rhadine subterranea*	TB?	0	0	0	0	0	0	0	0	0
ground beetle	carabid		0	0	0	1	0	1	0	0	5
ground beetle	*Tachys* sp.		0	0	0	0	0	0	0	0	0
rove beetles	Staphylinidae		1	0	64	1	3	4	0	2	8
mold beetles	*Batrisodes* sp.	TB/TP	0	0	1	0	0	0	1	0	0
beetle	Passalidae		1	0	0	0	0	0	0	0	0
beetle	Coleoptera		1	1	1	1	0	1	0	0	0
springtails	Collembola		279	120	515	49	17	128	154	48	556
dipluran	Campodeidae		2	1	0	1	0	0	0	0	29
silverfish	*Texoreddellia* sp.	TB	0	0	4	0	0	0	1	1	11
Bristletails	Microcoryphia		0	0	0	0	0	0	1	0	5
red imported fire ant	*Solenopsis invicta*		0	1	0	0	0	0	6	1	107
ant	*Myrmecodesmus*		0	0	0	0	0	0	0	0	0
ant	unidentified Formicidae		0	4	11	0	0	0	0	0	0
wasp	unidentified Hymenoptera		0	0	0	0	0	0	0	0	1
milliped	*Cambala*	TB	0	0	171	11	18	0	275	4	174
milliped	*Speodesmus*	TB	4	0	436	1	0	0	37	17	1
hothouse milliped	*Orthomorpha gracilis*		10	0	15	0	0	0	0	0	0
milliped	*Spirobola* sp.		0	0	2	0	0	0	0	0	1
brown milliped	Diplopoda		0	1	0	0	0	2	0	0	0
centipede	Scutigeridae		0	1	0	0	0	0	0	0	0

centipede	Lithobiomorph		1	1	0	2	0	0	0	1	1
centipede	Geophilomorph		0	0	0	0	0	0	0	0	0
spider	*Cicurina varians*	TP	6	9	12	2	7	38	22	26	35
spider	*Cicurina* sp. small, white	TB	0	11	6	1	2	6	7	5	15
spider	*Eidmannella* sp.	TB/TP	0	1	6	0	0	0	0	1	0
small spiders	unidentified Araneae		5	9	0	13	8	22	12	8	18
spider	surface Araneae		0	0	0	0	8	14	0	0	0
wolf spider	Lycosidae		0	1	0	0	0	0	0	0	0
jumping spider	Salticidae	AC	0	1	0	0	0	0	0	0	0
scorpion	*Pseudouroctunus reddelli*	TP	2	0	0	0	1	40	24	12	23
scorpion	*Centruroides*		0	0	1	0	1	0	0	0	3
mites	Acarina		0	1	10	3	0	0	0	0	354
snails	*Helicodiscus*	TP?	13	0	2	0	6	7	5	3	3
webworms	Mycetophilidae		0	1	0	0	0	0	0	1	5
mosquito	Culicidae		0	0	200	2	0	0	0	11	2
gnats	Diptera		0	25	1	6	0	4	1	3	13
flies	Diptera		0	0	6	0	0	1	0	5	0
cockroaches	Blatteria		4	1	1	1	0	0	2	0	0
earthworm	Annelida: Oligochaeta		4	0	0	0	1	0	0	0	0
surface isopod	Armadellid or Porcelionid		0	7	0	33	3	67	29	5	2
triconiscid isopod	*Brackenridgia cavernarum*	TB	13	0	11	1	2	0	0	0	4
Moth	Lepidoptera		1	1	261	0	0	6	2	12	6
book or bark louse	Psocoptera		6	0	2	0	3	7	25	0	0
leafhopper	Cicadellidae		0	0	0	0	0	0	0	0	0
assasin bug	Reduviidae: *Triatoma*		0	0	2	0	0	16	0	0	0
salamander	*Eurycea*	TB/TP	0	0	0	0	0	0	0	0	1
salamander	*Plethodon albagula*	TP	12	0	0	0	0	0	0	5	1
gulf coast toad	*Bufo valliceps*		0	0	0	0	1	0	0	0	0
cliff frog	*Syrrhophus marnocki*	TP	5	1	0	11	2	2	1	1	5
black tailed rattlesnake	*Crotalus molossus*		0	0	1	0	0	0	0	0	0
eastern pipistrelle	*Pipistrellus subflavus*	TX	1	0	0	0	0	0	0	0	0
		Total	**383**	**1452**	**4660**	**145**	**91**	**513**	**1007**	**1085**	**5458**

Table 6. Summary of seasonal activities carried out as part of this project. General invertebrate census was not carried out in August of 2005, except for in-cave cricket census carried out at three caves. Isotope sampling was teminated after the May 2006 samling period. Cricket exit counts were only carried out at select caves, and only once.

ISOTOPE SAMPLES	Aug 05	Nov 05	Feb 06	May 06	Aug 06
Academy Cave	x	x	x	x	
Blowing Sink	x	x	x	x	
Bone Pile	x	x	x	x	
Driskill	x	x	x	x	
Genesis	x	x	x	x	
LaCross	x	x	x	x	
Lost Oasis	x	x	x	x	
Slaughter Creek	x	x	x	x	
Surprise Sink	x	x	x	x	

INVERT COUNTS	Aug 05	Nov 05	Feb 06	May 06	Aug 06
Academy Cave		x	x	x	x
Blowing Sink	Crickets only	x	x	x	x
Bone Pile		x	x	x	x
Driskill	Crickets only	x	x	x	x
Genesis		Data Lost	x	x	x
LaCrosse		x	x	x	x
Lost Oasis		x	x	x	x
Slaughter Creek	Crickets only	x	x	x	x
Surprise Sink		x	x	x	x

CRICKET EXIT COUNTS	Aug 05	Nov 05	Feb 06	May 06	Aug 06
Academy Cave					
Blowing Sink	x				
Bone Pile	x				
Driskill					
Genesis	x				
LaCrosse				x	
Lost Oasis	x				
Slaughter Creek	x				
Surprise Sink					

Figure 16. *Ceuthophilus* (*Ceuthophilus*) sp. roosting on ceiling of Surprise Sink, Bexar County, Texas. Photo by Jean K. Krejca and Steve Taylor.

Table 7. Cricket exit counts at selected central Texas caves.

Cave	**Level of Human Impact**	**Date**	***C. secretus* adults**	***C. secretus* large nymphs**	***C. secretus* medium & small nymphs**	***C.* species B**	***C. cunicularis***
Genesis	High	23-Aug-05	0	4	2	0	0
Academy	High						
Driskill	High						
LaCrosse	Medium	24-May-06	48	17	5	0	0
Lost Oasis	Medium	17-Aug-05	357	4	11	4	0
Slaughter Creek	Medium	31-Aug-05	390	0	30	0	0
Blowing Sink	Low	31-Aug-05	35	0	0	0	0
Bone Pile	Low	23-Aug-05	2275	23	4	0	0
Surprise Sink	Low						

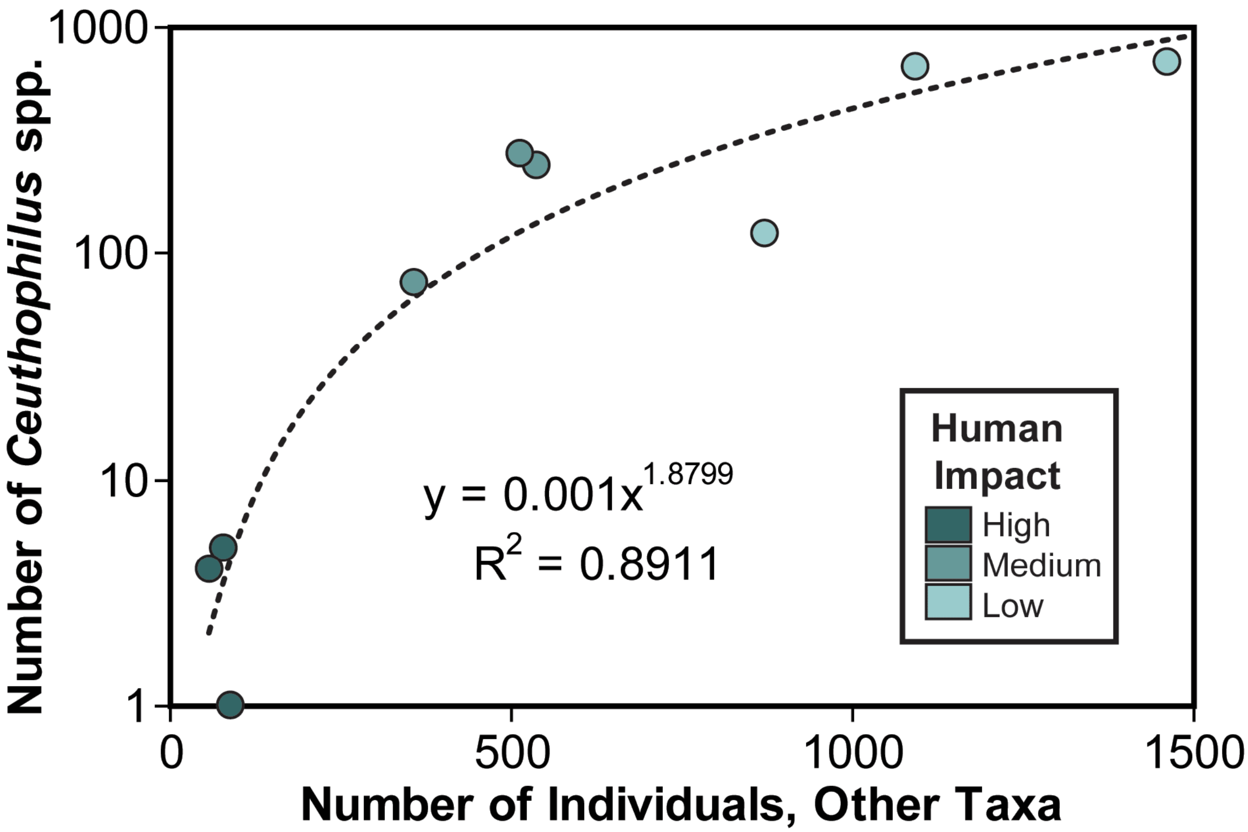

Figure 17. Correlation between number of cave crickets and number of other animals recorded from each of nine central Texas caves, with level of human impact indicated.

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were strongly correlated with the total number of cave crickets (Figure 17). While the finding that 89% of the variation in numbers of other animals was explained by variation in number of *Ceuthophilus* spp. is rather remarkable[5], it is consistent with what we see in the isotope plots (Figures 7, 8, 10, 11, 12), wherein there is a strong link between utilization of vegetation as a food source by surface-foraging *C.* (*C.*) *secretus* and *C.* (*C.*) species B.

[5] This is especially surprising because there is so much individual variation among caves – in their morphology, size, shape, exposure, slope, etc., that even though such a trend might be expected, the noise from other confounding factors might be expected to result in a somewhat weaker correlation.

Looking more closely at these same data in relation to the two measures of human impact (modified/natural and impervious/permeable), we see strong correlations for both cave cricket and other cave inhabitants with percentage of impervious cover (Figure 18) and the percentage of modified habitat (Figure 19) for both the 11.2 acre and 90 acre sampling areas. Impervious cover explained 89 (crickets) to 91 (other organisms) percent of the variation in numbers of individuals when scored for an 11.2 acre impact sampling area, and still had very strong explanatory value in the 90 acre sample area, at 85 and 97 percent of the variation in numbers explained for crickets and other organisms, respetively. The same pattern holds for percentage of modified habitat, with variations in percentage of modified habitat explaining from 75 to 96 percent of the variation in numbers of individuals, and the same loglinear trend seen at both sample area sizes. These data indicate that at preserve sizes greater than 11.2 acres (centered on the cave entrance), the cave ecosystem is still sensitive to changes in cover type. That is, our data suggest that a preserve size of 11.2 acres is not sufficient to maintain a fully functioning cave ecosystem in central Texas.

While it is intuitive that more modified habitat and impervious cover around a cave decreases the habitat quality and therefore negatively impacts the populations of cavernicoles, this is the first study to quantify those variables and show strong correlations for central Texas cave ecosytems. The slopes shown in Figures 17-19 are a start towards finding the tipping point at which urbanization degrades the cave community. Other researchers have attempted to examine impact of urbanization above caves by monitoring rare and endangered predator populations (Sprouse *et al*. 2007), but these animals have long life spans, and the time lag between habitat degradation and population decline distorts the view of what is happening to the ecosystem. The impact levels examined here provide a realistic pictures of how urbanization happens around caves, and can help land managers determine their comfort level for development within 120 and 340 meters of occupied caves, and the subsequent risks posed to the endangered species.

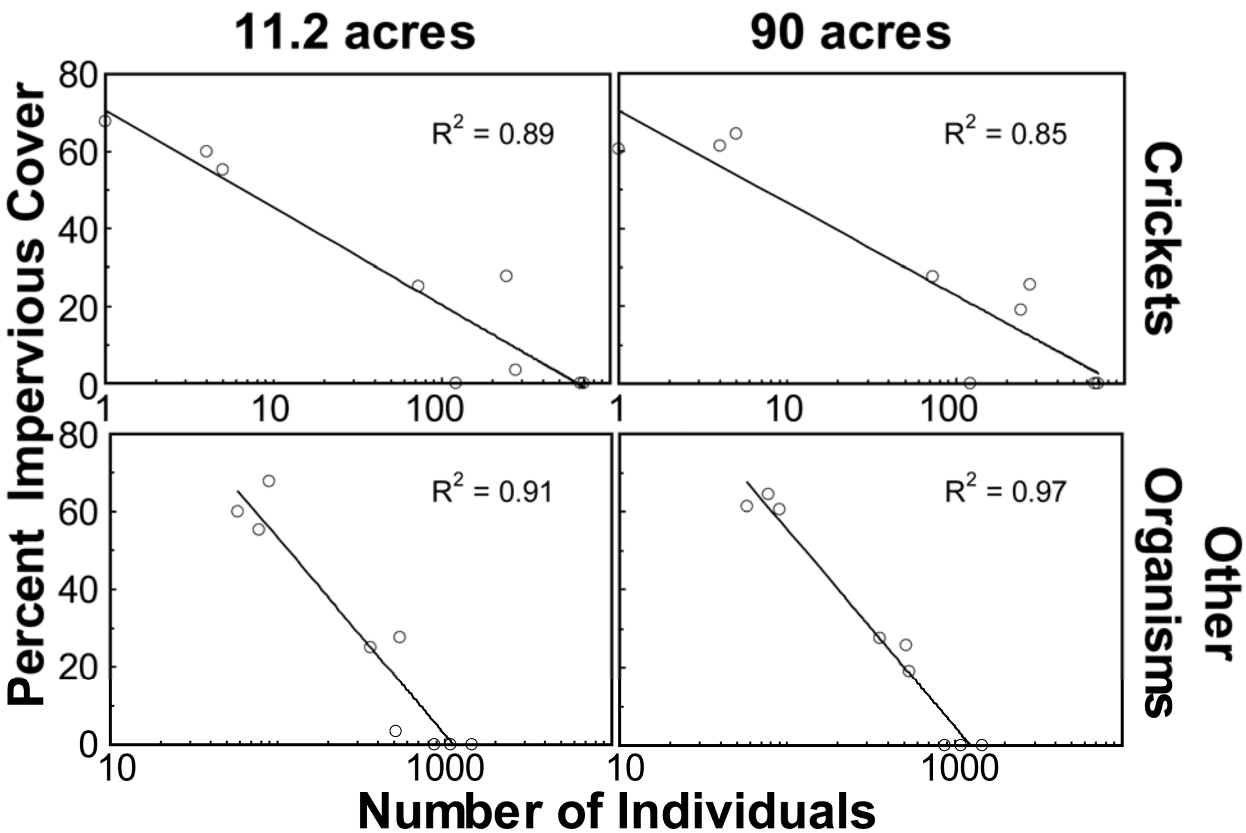

Figure 18. Percentage impervious cover (from ground-truthed aerial photography) in relation to total number of individuals (log_{10} scale) for cave crickets and other cave inhabitants at nine central Texas caves.

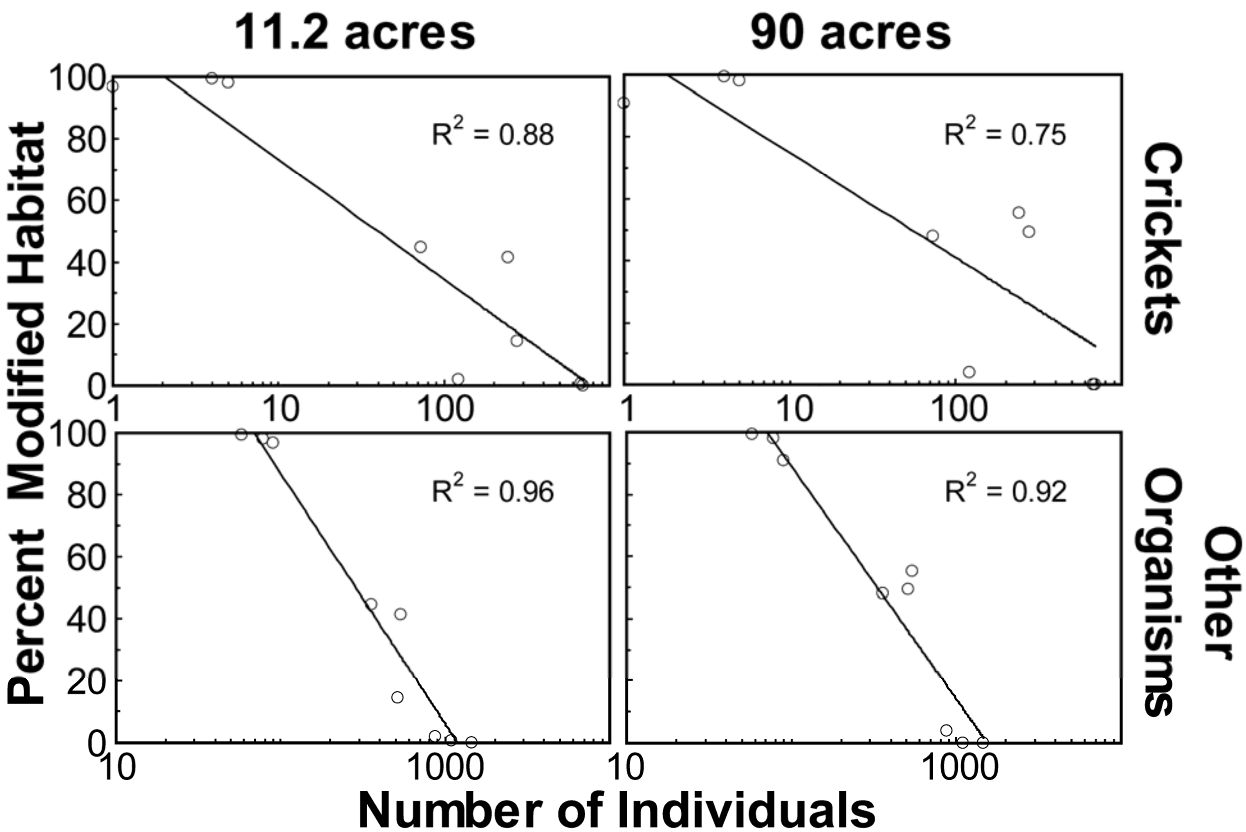

Figure 19. Percentage modified habitat (from ground-truthed aerial photography) in relation to total number of individuals ($\log_{10}$ scale) for cave crickets and other cave inhabitants at nine central Texas caves.

Conclusions & Recommendations

Both of the factors examined in this study, trophic position and population levels, were found to vary with level of impact around caves. Even at impact levels defined as `medium' - places where the entrances themselves are in undisturbed woodlots varying from the size of several house lots to tens of acres in size but urbanization is nearby – there are noticeable differences in cavernicole population levels. For land managers faced with high land values in urbanizing areas, it is increasingly important to know the minimum size for a preserve, and to understand what characteristics are needed for a site to be considered suitable. Our results demonstrate that even though small areas within urban zones may support a cave community where troglobites are occasionally seen (e.g., Genesis Cave, Driskill Cave), these populations are significantly lower than expected when compared to more natural settings, and the trophic position of the high human impact cave ecosystem is altered. In short, when cricket (or, equivalently, cavernicole) numbers are low, this reflects elevated levels of human disturbance, and probably a reduction in food input (natural litter input, cricket guano) does not bode well for the endangered karst invertebrates. To clarify where that cutoff is between an unimpacted ecosystem and an impacted one, further study is needed, perhaps replicating portions of this study on a much larger scale, with a variety of caves across the entire range of levels of human impact. As we have demonstrated a strong correlation between the isotope results and the cave census results, considerable savings could be afforde by focusing primarily on in-cave census along with classification of levels of impact.

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Appendix A. Scoring of levels of human impact at nine caves based on overlay of points on aerial photographs.

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Lost Oasis 120m**
7	4	0	1	0	0	2	0	0	0	0	
9	5	0	1	0	0	1	0	1	1	0	
11	1	0	3	0	0	4	3	0	0	0	
13	2	1	4	0	0	4	2	0	0	0	
13	3	3	4	0	0	3	0	0	0	0	
14	3	2	5	0	0	3	1	0	0	0	
14	4	3	4	0	0	3	0	0	0	0	
14	4	3	5	0	0	1	1	0	0	0	
13	3	1	6	0	0	3	0	0	0	0	
13	7	1	4	0	0	1	0	0	0	0	
11	7	0	3	0	0	1	0	0	0	0	
10	5	1	1	0	0	1	0	2	0	0	
7	0	4	0	1	0	1	0	1	0	0	
3	0	0	0	0	0	1	0	2	0	0	
Total											
152	48	19	41	1	0	29	7	6	1		
	31.6	12.5	27.0	0.7	0.0	19.1	4.6	3.9	0.7	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Lost Oasis 340m**
7	2	4	0	0	0	0	1	0	0	0	
9	2	5	1	0	0	1	0	0	0	0	
11	3	1	1	2	0	2	1	1	0	0	
13	2	4	3	0	0	0	0	4	0	0	
13	2	4	3	0	0	1	0	3	0	0	
14	2	1	5	0	0	3	1	2	0	0	
14	6	4	2	0	0	2	0	0	0	0	
14	6	2	4	1	0	0	0	1	0	0	
13	2	4	4	3	0	0	0	0	0	0	
13	3	4	3	3	0	0	0	0	0	0	
11	3	3	2	1	0	0	0	2	0	0	
10	3	5	1	0	0	1	0	0	0	0	
7	2	1	1	1	0	0	0	2	0	0	
3	0	2	0	0	0	1	0	0	0	0	
Total											
152	38	44	30	11	0	11	3	15	0		
	25.0	28.9	19.7	7.2	0.0	7.2	2.0	9.9	0.0	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Academy 120 m**
7	0	3	0	2	0	1	1	0	0	0	
9	0	4	0	0	0	1	1	3	0	0	
11	0	1	0	1	0	3	3	3	0	0	
13	0	3	0	1	0	4	1	4	0	0	
13	0	2	0	1	0	6	1	2	1	0	
14	0	1	0	2	1	5	2	2	1	0	
14	0	1	1	1	0	3	1	5	2	0	
14	0	3	1	1	0	4	2	3	0	0	
13	0	4	1	1	0	4	1	2	0	0	
13	0	3	0	6	0	1	1	2	0	0	
11	0	2	0	7	0	1	0	1	0	0	
10	0	0	0	8	0	2	0	0	0	0	
7	0	1	0	0	0	4	0	2	0	0	
3	0	1	0	0	0	2	0	0	0	0	
Total											
152	0	29	3	31	1	41	14	29	4		
	0.0	19.1	2.0	20.4	0.7	27.0	9.2	19.1	2.6	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Academy 340 m**
7	0	0	0	0	1	6	0	0	0	0	
9	0	1	1	0	0	4	1	2	0	0	
11	0	1	0	0	0	2	1	7	0	0	
13	0	4	0	1	0	2	4	2	0	0	
13	0	5	0	2	0	2	2	2	0	0	
14	0	3	0	1	0	4	2	4	0	0	
14	0	2	1	1	0	6	1	3	0	0	
14	0	4	0	1	0	5	0	4	0	0	
13	0	1	0	4	0	4	0	4	0	0	
13	0	0	0	4	0	5	0	4	0	0	
11	0	3	1	1	0	3	0	3	0	0	
10	0	3	0	5	0	1	0	1	0	0	
7	0	1	0	1	0	5	0	0	0	0	
3	0	1	0	0	0	2	0	0	0	0	
Total											
152	0	29	3	21	1	51	11	36	0		
	0.0	19.1	2.0	13.8	0.7	33.6	7.2	23.7	0.0	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**LaCross 120m**
7	1	1	1	0	0	3	0	1	0	0	
9	1	1	3	0	0	3	0	1	0	0	
11	3	3	2	0	0	1	1	1	0	0	
13	2	1	4	1	0	3	1	1	0	0	
13	4	2	4	0	0	1	0	2	0	0	
14	2	4	6	0	0	0	0	1	1	0	
14	3	0	6	1	0	1	0	3	0	0	
14	4	1	5	1	0	2	0	1	0	0	
13	4	3	2	2	0	1	0	1	0	0	
13	5	3	2	1	0	1	0	1	0	0	
11	3	1	3	1	0	2	0	1	0	0	
10	3	0	4	0	0	3	0	0	0	0	
7	3	1	2	0	0	1	0	0	0	0	
3	2	0	0	0	1	0	0	0	0	0	
Total											
152	40	21	44	7	1	22	2	14	1		
	26.3	13.8	28.9	4.6	0.7	14.5	1.3	9.2	0.7	100.0	

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Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**LaCross 340m**
7	1	2	1	1	0	0	0	2	0	0	
9	2	0	0	2	0	4	0	1	0	0	
11	0	4	0	1	0	3	0	3	0	0	
13	1	3	3	1	0	3	0	2	0	0	
13	1	3	4	1	0	4	0	0	0	0	
14	5	1	2	0	0	2	0	4	0	0	
14	2	3	4	0	0	0	0	5	0	0	
14	5	4	1	0	0	2	0	2	0	0	
13	6	2	2	0	1	0	0	2	0	0	
13	8	0	5	0	0	0	0	0	0	0	
11	3	0	6	0	1	1	0	0	0	0	
10	5	0	5	0	0	0	0	0	0	0	
7	3	0	2	0	0	2	0	0	0	0	
3	0	1	2	0	0	0	0	0	0	0	
Total											
152	42	23	37	6	2	21	0	21	0		
	27.6	15.1	24.3	3.9	1.3	13.8	0.0	13.8	0.0	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**SlaughterCrk 120 m**
7	3	0	4	0	0	0	0	0	0	0	
9	6	0	3	0	0	0	0	0	0	0	
11	3	0	8	0	0	0	0	0	0	0	
13	6	0	7	0	0	0	0	0	0	0	
13	2	0	11	0	0	0	0	0	0	0	
14	3	0	11	0	0	0	0	0	0	0	
14	5	0	9	0	0	0	0	0	0	0	
14	5	0	9	0	0	0	0	0	0	0	
13	4	0	9	0	0	0	0	0	0	0	
13	8	0	5	0	0	0	0	0	0	0	
11	3	2	6	0	0	0	0	0	0	0	
10	0	7	0	2	0	0	0	1	0	0	
7	0	2	0	1	0	0	0	4	0	0	
3	0	3	0	0	0	0	0	0	0	0	
Total											
152	48	14	82	3	0	0	0	5	0		
	31.6	9.2	53.9	2.0	0.0	0.0	0.0	3.3	0.0	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**SlaughterCrk 340 m**
7	6	0	0	0	0	0	0	0	1	0	
9	1	0	7	0	0	0	0	0	1	0	
11	3	1	7	0	0	0	0	0	0	0	
13	4	1	5	0	0	2	0	0	1	0	
13	4	0	8	0	0	0	1	0	0	0	
14	3	0	9	0	0	2	0	0	0	0	
14	4	4	5	1	0	0	0	0	0	0	
14	3	0	3	0	0	6	0	2	0	0	
13	0	6	2	1	0	3	0	1	0	0	
13	0	3	0	1	0	4	4	1	0	0	
11	0	1	2	1	0	2	0	5	0	0	
10	0	3	0	2	0	0	1	4	0	0	
7	0	5	0	1	0	1	0	0	0	0	
3	0	2	1	0	0	0	0	0	0	0	
Total											
152	28	26	49	7	0	20	6	13	3		
	18.4	17.1	32.2	4.6	0.0	13.2	3.9	8.6	2.0	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Driskill 120 m**
7	0	3	0	0	0	1	0	0	3	0	
9	0	3	0	0	0	6	0	0	0	0	
11	0	4	0	0	0	7	0	0	0	0	
13	0	1	0	0	0	12	0	0	0	0	
13	0	0	0	0	0	13	0	0	0	0	
14	0	0	0	0	0	14	0	0	0	0	
14	0	6	4	0	0	3	0	0	1	0	
14	0	7	1	0	0	5	0	0	1	0	
13	0	1	0	0	0	12	0	0	0	0	
13	0	5	0	0	0	8	0	0	0	0	
11	0	3	0	1	0	7	0	0	0	0	
10	0	3	0	1	0	6	0	0	0	0	
7	0	0	0	0	0	7	0	0	0	0	
3	0	1	0	0	0	2	0	0	0	0	
Total											
152	0	37	5	2	0	103	0	0	5		
	0.0	24.3	3.3	1.3	0.0	67.8	0.0	0.0	3.3	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails		**Driskill 340 m**
7	0	2	5	0	0	0	0	0	0	0	
9	0	3	6	0	0	0	0	0	0	0	
11	0	3	2	1	0	3	1	1	0	0	
13	0	5	0	2	1	2	0	3	0	0	
13	0	2	0	2	1	3	1	3	1	0	
14	0	4	0	0	0	10	0	0	0	0	
14	0	4	1	0	0	9	0	0	0	0	
14	0	4	0	0	0	10	0	0	0	0	
13	0	5	0	0	0	8	0	0	0	0	
13	0	2	0	0	0	9	0	2	0	0	
11	0	1	0	0	0	8	0	2	0	0	
10	0	2	0	1	0	6	0	1	0	0	
7	0	0	0	0	0	7	0	0	0	0	
3	0	0	0	0	0	3	0	0	0	0	
Total											
152	0	37	14	6	2	78	2	12	1		
	0.0	24.3	9.2	3.9	1.3	51.3	1.3	7.9	0.7	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Genesis 120 m**
7	0	1	0	1	0	1	0	4	0	0	
9	0	1	0	2	0	4	0	2	0	0	
11	0	2	0	1	0	5	0	3	0	0	
13	0	2	0	3	0	7	1	0	0	0	
13	0	1	0	1	0	10	1	0	0	0	
14	0	4	0	2	0	7	1	0	0	0	
14	0	6	0	2	0	4	0	0	2	0	
14	0	6	1	1	0	4	0	0	2	0	
13	0	4	0	1	0	5	0	0	3	0	
13	0	3	0	1	0	4	3	0	2	0	
11	0	0	0	0	0	4	0	3	4	0	
10	0	0	0	0	0	7	0	1	2	0	
7	0	0	0	0	0	5	0	2	0	0	
3	0	0	0	0	0	3	0	0	0	0	
Total											
152	0	30	1	15	0	70	6	15	15		
	0.0	19.7	0.7	9.9	0.0	46.1	3.9	9.9	9.9	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Genesis 340 m**
7	0	0	0	3	0	4	0	0	0	0	
9	0	0	0	1	0	4	0	4	0	0	
11	0	0	0	2	0	6	0	3	0	0	
13	0	2	0	3	0	6	0	2	0	0	
13	0	3	0	1	0	3	1	5	0	0	
14	0	4	0	1	0	7	1	1	0	0	
14	0	3	0	2	0	8	0	1	0	0	
14	0	3	0	3	0	2	1	3	2	0	
13	0	3	0	0	1	2	2	4	1	0	
13	0	3	0	0	0	2	1	3	4	0	
11	0	4	0	0	0	2	1	3	1	0	
10	1	2	0	0	0	6	0	1	0	0	
7	0	2	0	2	0	3	0	0	0	0	
3	0	0	0	2	0	0	0	1	0	0	
Total											
152	1	29	0	20	1	55	7	31	8		
	0.7	19.1	0.0	13.2	0.7	36.2	4.6	20.4	5.3	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**BonePile120m**
7	2	0	5	0	0	0	0	0	0	0	
9	4	0	5	0	0	0	0	0	0	0	
11	3	0	8	0	0	0	0	0	0	0	
13	1	0	12	0	0	0	0	0	0	0	
13	1	0	12	0	0	0	0	0	0	0	
14	5	0	9	0	0	0	0	0	0	0	
14	8	0	6	0	0	0	0	0	0	0	
14	4	0	10	0	0	0	0	0	0	0	
13	0	0	13	0	0	0	0	0	0	0	
13	0	0	13	0	0	0	0	0	0	0	
11	0	0	11	0	0	0	0	0	0	0	
10	0	0	10	0	0	0	0	0	0	0	
7	0	0	7	0	0	0	0	0	0	0	
3	0	0	3	0	0	0	0	0	0	0	
Total											
152	28	0	124	0	0	0	0	0	0		
	18.4	0.0	81.6	0.0	0.0	0.0	0.0	0.0	0.0	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**BonePile340m**
7	4	0	3	0	0	0	0	0	0	0	
9	2	0	7	0	0	0	0	0	0	0	
11	2	0	9	0	0	0	0	0	0	0	
13	1	0	12	0	0	0	0	0	0	0	
13	4	0	9	0	0	0	0	0	0	0	
14	2	0	12	0	0	0	0	0	0	0	
14	2	0	12	0	0	0	0	0	0	0	
14	1	0	13	0	0	0	0	0	0	0	
13	0	0	13	0	0	0	0	0	0	0	
13	2	0	11	0	0	0	0	0	0	0	
11	1	0	10	0	0	0	0	0	0	0	
10	0	0	10	0	0	0	0	0	0	0	
7	0	0	7	0	0	0	0	0	0	0	
3	0	0	3	0	0	0	0	0	0	0	
Total											
152	21	0	131	0	0	0	0	0	0		
	13.8	0.0	86.2	0.0	0.0	0.0	0.0	0.0	0.0	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Surprise120m**
7	4	0	3	0	0	0	0	0	0	0	
9	2	0	7	0	0	0	0	0	0	0	
11	3	0	7	0	1	0	0	0	0	0	
13	4	0	9	0	0	0	0	0	0	0	
13	1	0	12	0	0	0	0	0	0	0	
14	3	0	11	0	0	0	0	0	0	0	
14	4	0	10	0	0	0	0	0	0	0	
14	4	0	10	0	0	0	0	0	0	0	
13	2	0	11	0	0	0	0	0	0	0	
13	0	0	13	0	0	0	0	0	0	0	
11	2	0	9	0	0	0	0	0	0	0	
10	0	0	10	0	0	0	0	0	0	0	
7	0	0	7	0	0	0	0	0	0	0	
3	0	0	3	0	0	0	0	0	0	0	
Total											
152	29	0	122	0	1	0	0	0	0		
	19.1	0.0	80.3	0.0	0.7	0.0	0.0	0.0	0.0	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Surprise 340m**
7	0	0	7	0	0	0	0	0	0	0	
9	1	0	8	0	0	0	0	0	0	0	
11	4	0	7	0	0	0	0	0	0	0	
13	2	0	11	0	0	0	0	0	0	0	
13	3	0	10	0	0	0	0	0	0	0	
14	3	0	11	0	0	0	0	0	0	0	
14	3	0	11	0	0	0	0	0	0	0	
14	4	0	10	0	0	0	0	0	0	0	
13	1	0	12	0	0	0	0	0	0	0	
13	3	0	10	0	0	0	0	0	0	0	
11	1	0	10	0	0	0	0	0	0	0	
10	1	0	9	0	0	0	0	0	0	0	
7	0	0	7	0	0	0	0	0	0	0	
3	0	0	3	0	0	0	0	0	0	0	
Total											
152	26	0	126	0	0	0	0	0	0		
	17.1	0.0	82.9	0.0	0.0	0.0	0.0	0.0	0.0	100.0	

Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Blowing 120m**
7	2	0	5	0	0	0	0	0	0	0	
9	1	0	8	0	0	0	0	0	0	0	
11	0	0	11	0	0	0	0	0	0	0	
13	0	0	13	0	0	0	0	0	0	0	
13	2	0	11	0	0	0	0	0	0	0	
14	2	0	11	0	1	0	0	0	0	0	
14	3	0	10	0	1	0	0	0	0	0	
14	6	0	7	0	1	0	0	0	0	0	
13	5	0	8	0	0	0	0	0	0	0	
13	9	0	4	0	0	0	0	0	0	0	
11	7	0	4	0	0	0	0	0	0	0	
10	7	0	3	0	0	0	0	0	0	0	
7	6	0	1	0	0	0	0	0	0	0	
3	3	0	0	0	0	0	0	0	0	0	
Total											
152	53	0	96	0	3	0	0	0	0		
	34.9	0.0	63.2	0.0	2.0	0.0	0.0	0.0	0.0	100.0	

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Points Per Line	Grass /Herb	Yard	Trees/ Shrubs Natural	Trees/Shurbs Cultivated	Dirt/ gravel road	Paved Road	Cement Sidwald	Building/ Structure	Bare Ground/ dirt trails	Total Check	**Blowing 340 m**
7	2	0	5	0	0	0	0	0	0	0	
9	1	0	8	0	0	0	0	0	0	0	
11	1	0	10	0	0	0	0	0	0	0	
13	3	0	10	0	0	0	0	0	0	0	
13	3	0	10	0	0	0	0	0	0	0	
14	5	0	8	0	1	0	0	0	0	0	
14	5	0	8	0	1	0	0	0	0	0	
14	9	0	4	0	1	0	0	0	0	0	
13	7	0	6	0	0	0	0	0	0	0	
13	8	0	4	0	1	0	0	0	0	0	
11	5	0	4	0	2	0	0	0	0	0	
10	6	0	4	0	0	0	0	0	0	0	
7	5	0	2	0	0	0	0	0	0	0	
3	1	0	2	0	0	0	0	0	0	0	
Total											
152	61	0	85	0	6	0	0	0	0		
	40.1	0.0	55.9	0.0	3.9	0.0	0.0	0.0	0.0	100.0	

Appendix B. Summary of stable isotope data analyzed in this report.

Date	Cave	Sample	Scientific Name	Common Name	Family	Order	Parts sampled	δ15N	%N	δ13C	%C
15-May-06	Blowing Sink	1907	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	4.383	11.329	-23.324	42.656
6-Nov-05	Blowing Sink	1251	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	6.148	12.395	-21.266	44.503
15-May-06	Blowing Sink	1896	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	6.474	11.743	-22.882	42.909
30-May-06	Surprise Sink	1860	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	6.555	13.160	-23.115	40.270
15-May-06	Blowing Sink	1908	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.328	11.438	-21.913	40.123
15-Nov-05	Surprise Sink	1313	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.384	12.770	-21.952	
30-May-06	Surprise Sink	1858	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.390	10.490	-22.872	47.740
30-May-06	Surprise Sink	1858	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.431	10.320	-22.935	47.530
14-Feb-06	Surprise Sink	1563	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.814	11.010	-22.632	49.600
30-May-06	Surprise Sink	1856	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.843	12.230	-22.090	42.120
14-Feb-06	Bone Pile	1504	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.269	11.620	-22.254	48.930
30-May-06	Surprise Sink	1853	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.393	12.350	-22.830	46.550
30-May-06	Surprise Sink	1859	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.567	12.930	-22.260	43.680
14-Feb-06	Surprise Sink	1562	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.823	11.300	-21.802	44.310
15-Nov-05	Surprise Sink	1312	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.863	12.430	-21.630	
15-Nov-05	Surprise Sink	1314	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.938	11.470	-22.045	
31-Aug-05	Blowing Sink	1202	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.975	11.220	-21.641	45.010
15-Nov-05	Surprise Sink	1311	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.056	12.520	-22.473	
14-Feb-06	Surprise Sink	1561	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.232	12.220	-22.100	46.330
30-May-06	Surprise Sink	1855	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.341	13.500	-21.725	46.740
14-Feb-06	Surprise Sink	1561	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.419	11.450	-22.296	44.540
14-Feb-06	Surprise Sink	1564	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	11.510	11.650	-22.352	44.270
15-May-06	Blowing Sink	1898	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism			-7.768	13.215
30-May-06	Surprise Sink	1857	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism			-23.053	53.550
30-May-06	Surprise Sink	1854	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism			-22.935	47.440
24-May-06	Slaughter Creek	1729	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	6.193	10.390	-22.881	42.020
24-May-06	Slaughter Creek	1739	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	6.291	9.250	-22.130	39.390
24-May-06	Slaughter Creek	1732	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	6.653	9.250	-22.304	47.900
29-Nov-05	Slaughter Creek	1416	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	7.065	11.400	-22.486	39.200
24-May-06	Slaughter Creek	1736	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	7.498	10.510	-21.926	46.870
22-May-06	Lost Oasis	1656	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	7.804	11.730	-22.581	42.450
24-May-06	Slaughter Creek	1734	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	7.953	9.000	-21.545	39.730
22-May-06	Lost Oasis	1655	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.486	10.360	-22.898	44.390
29-Nov-05	Slaughter Creek	1415	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.529	12.240	-21.082	46.730
29-Nov-05	Slaughter Creek	1415	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.572	11.540	-21.293	44.870
24-May-06	Slaughter Creek	1738	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.692	12.140	-21.682	48.260
22-May-06	Lost Oasis	1659	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.780	9.650	-21.732	45.790
22-May-06	Lost Oasis	1655	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.835	8.280	-22.608	32.580
28-Feb-06	Lost Oasis	1625	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.966	11.410	-22.542	43.570
24-May-06	La Crosse	1699	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.142	11.870	-20.956	46.770
22-May-06	Lost Oasis	1660	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.236	9.890	-22.293	41.090
24-May-06	Slaughter Creek	1731	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.367	11.600	-20.990	44.480
28-Feb-06	Lost Oasis	1624	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.781	11.430	-22.367	46.470
28-Feb-06	Lost Oasis	1627	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	9.958	11.900	-22.312	42.680
28-Feb-06	Lost Oasis	1626	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.000	9.770	-22.432	40.630
29-Nov-05	Slaughter Creek	1418	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.304	12.430	-22.914	43.370
22-May-06	Lost Oasis	1658	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.371	9.670	-22.485	37.230
24-May-06	La Crosse	1698	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.422	8.520	-20.380	35.400
22-May-06	Lost Oasis	1657	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.678	10.500	-21.937	43.020
24-May-06	La Crosse	1694	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	11.057	11.760	-20.206	44.300
22-May-06	Lost Oasis	1654	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	11.064	11.620	-21.719	42.790
24-May-06	La Crosse	1696	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	11.185	11.160	-20.178	46.090
29-Nov-05	Slaughter Creek	1417	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	11.716	11.210	-23.270	39.930

24-May-06	Slaughter Creek	1735	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	12.237	10.680	-22.156	46.880
24-May-06	La Crosse	1695	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	15.386	9.050	-17.796	52.890
24-May-06	La Crosse	1697	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism			-20.757	49.780
24-May-06	Slaughter Creek	1730	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism			-22.695	47.210
24-May-06	Slaughter Creek	1733	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism			-22.601	44.060
23-Aug-05	Genesis	1084	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	7.310	12.194	-20.300	44.523
23-Aug-05	Genesis	1085	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.190	11.473	-22.040	42.207
30-May-06	Genesis	1837	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	8.283	11.030	-22.367	46.330
30-May-06	Genesis	1836	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	10.546	12.650	-17.992	45.570
31-Aug-05	Driskill	1227	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	12.115	10.830	-22.625	44.860
25-May-06	Academy	1767	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	12.453	11.040	-23.388	44.330
25-May-06	Academy	1768	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	13.869	12.260	-22.034	43.520
26-Aug-05	Academy	1193	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	14.421	11.520	-22.257	47.760
25-May-06	Academy	1765	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	14.464	11.570	-21.881	42.180
25-May-06	Academy	1766	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	15.356	11.410	-20.824	45.860
26-Aug-05	Academy	1192	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	15.417	9.960	-22.004	40.400
30-Nov-05	Academy	1426	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism	15.925	12.050	-20.099	42.850
30-May-06	Genesis	1838	Cicurina sp.	TP or TB Spider	Dictynidae	Araneae	Organism			-22.543	47.260
30-May-06	Surprise Sink	1852	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	7.978	9.390	-21.263	34.620
30-May-06	Bone Pile	1795	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.158	10.260	-23.280	46.770
30-May-06	Bone Pile	1794	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.739	11.230	-22.411	43.520
30-May-06	Bone Pile	1794	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.780	11.170	-22.400	43.730
14-Feb-06	Surprise Sink	1565	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	10.748	12.030	-21.723	46.570
23-Nov-05	La Crosse	1387	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	7.310	11.370	-23.227	42.590
23-Nov-05	La Crosse	1386	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	7.352	11.830	-23.388	44.570
8-Nov-05	Lost Oasis	1278	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	7.954	11.339	-23.693	44.134
8-Nov-05	Lost Oasis	1273	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	8.764	11.650	-23.347	38.903
8-Nov-05	Lost Oasis	1274	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	8.773	12.883	-23.265	43.188
31-Aug-05	Slaughter Creek	1164	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	8.917	10.710	-21.862	51.640
8-Nov-05	Lost Oasis	1276	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.110	12.111	-22.262	41.771
26-Aug-05	La Crosse	1128	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.660	12.253	-22.500	45.348
16-Feb-06	Slaughter Creek	1580	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.856	9.380	-22.171	33.190
8-Nov-05	Lost Oasis	1277	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.878	12.680	-21.902	44.288
31-Aug-05	Slaughter Creek	1163	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.907	11.440	-21.530	49.340
16-Feb-06	Slaughter Creek	1582	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	10.221	10.840	-22.655	38.490
31-Aug-05	Slaughter Creek	1165	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	10.410	11.800	-22.330	48.150
16-Feb-06	Slaughter Creek	1581	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	10.625	10.960	-21.336	38.960
8-Nov-05	Lost Oasis	1275	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	10.785	12.036	-22.396	42.081
26-Aug-05	La Crosse	1129	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	11.060	10.695	-22.110	47.664
26-Aug-05	La Crosse	1129	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	11.280	11.286	-21.890	48.224
16-Feb-06	Slaughter Creek	1581	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	11.436	10.160	-21.380	36.260
26-Aug-05	La Crosse	1127	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	11.730	12.154	-20.920	46.616
26-Aug-05	La Crosse	1131	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	12.250	11.906	-20.570	47.734
26-Aug-05	La Crosse	1130	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	12.900	12.473	-19.710	46.517
31-Aug-05	Slaughter Creek	1162	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	12.923	12.940	-20.494	49.730
23-Nov-05	La Crosse	1385	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	15.925	12.270	-18.749	40.950
23-Nov-05	La Crosse	1383	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	15.961	11.460	-18.807	46.450
23-Feb-06	La Crosse	1599	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	16.993	11.350	-17.916	38.900
21-Nov-05	Genesis	1363	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	7.976	11.640	-22.675	43.200
21-Nov-05	Genesis	1363	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	7.979	11.680	-22.529	43.380
21-Nov-05	Genesis	1362	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	7.999	10.430	-22.106	37.110
21-Nov-05	Genesis	1358	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	8.246	9.980	-21.504	38.980
21-Nov-05	Genesis	1361	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	8.586	8.440	-20.303	31.730
21-Nov-05	Genesis	1359	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.718	10.930	-20.593	44.400
21-Nov-05	Genesis	1360	Cicurina varians	TP Spider	Dictynidae	Araneae	Organism	9.914	11.980	-18.970	43.640
28-Jul-05	Surprise Sink	1022	unidentified spider	TP Spider	unidentified spider	Araneae	Organism	8.190	12.300	-22.930	46.350
28-Jul-05	Surprise Sink	1024	unidentified spider	TP Spider	unidentified spider	Araneae	Organism	9.260	12.670		
28-Jul-05	Surprise Sink	1021	unidentified spider	TP Spider	unidentified spider	Araneae	Organism	10.380	12.790	-22.760	47.860
17-Aug-05	Lost Oasis	1047	unidentified spider	TP Spider	unidentified spider	Araneae	Organism	8.170	11.900	-22.750	44.970
17-Aug-05	Lost Oasis	1048	unidentified spider	TP Spider	unidentified spider	Araneae	Organism	8.210	9.910	-22.970	41.350

17-Aug-05	Lost Oasis	1045	unidentified spider	TP Spider	unidentified spider	Araneae	Organism	9.820	12.400	-23.430	43.960
17-Aug-05	Lost Oasis	1046	unidentified spider	TP Spider	unidentified spider	Araneae	Organism	10.090	12.350	-22.710	43.390
17-Aug-05	Lost Oasis	1049	unidentified spider	TP Spider	unidentified spider	Araneae	Organism	10.830	11.030	-22.870	39.620
29-Nov-05	Driskill	1409	unidentified Blatteria	Cockroach	unidentified Blatteria	Blatteria	Organism	4.471	14.040	-22.682	43.370
30-Nov-05	Academy	1428	unidentified Blatteria	Cockroach	unidentified Blatteria	Blatteria	Organism	7.950	11.360	-22.796	43.140
15-May-06	Blowing Sink	1914	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	0.341	10.677	-24.711	41.754
6-Nov-05	Blowing Sink	1252	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	3.005	10.411	-23.608	45.856
30-May-06	Bone Pile	1812	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	4.300	9.080	-22.067	48.980
23-Aug-05	Bone Pile	1102	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	4.840	9.828	-24.020	50.911
30-May-06	Surprise Sink	1887	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	4.953	9.030	-22.264	37.589
28-Jul-05	Surprise Sink	1033	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	5.540	8.660	-24.280	52.680
28-Jul-05	Surprise Sink	1030	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	6.070	8.090	-24.240	50.660
28-Jul-05	Surprise Sink	1031	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	6.340	8.320	-24.360	53.500
28-Jul-05	Surprise Sink	1034	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	6.380	8.200	-24.310	51.950
15-Nov-05	Bone Pile	1322	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	6.815	10.550	-21.560	39.210
14-Feb-06	Surprise Sink	1568	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	7.029	12.920	-21.940	41.970
28-Jul-05	Surprise Sink	1032	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	7.700	9.450	-23.800	54.010
15-Nov-05	Surprise Sink	1315	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	8.616	12.860	-22.027	
31-Aug-05	Blowing Sink	1215	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-23.720	43.290
23-Nov-05	La Crosse	1398	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	3.654	6.780	-24.868	35.880
22-May-06	Lost Oasis	1675	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	6.036	5.470	-22.096	30.500
8-Nov-05	Lost Oasis	1272	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	6.383	13.577	-22.246	40.322
23-Nov-05	La Crosse	1399	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-19.400	34.620
17-Aug-05	Lost Oasis	1065	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-24.800	39.100
17-Aug-05	Lost Oasis	1068	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-24.530	26.135
17-Aug-05	Lost Oasis	1067	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-24.300	62.531
28-Feb-06	Lost Oasis	1633	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-24.225	46.250
17-Aug-05	Lost Oasis	1069	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-24.170	24.721
17-Aug-05	Lost Oasis	1066	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-23.840	119.274
24-May-06	Slaughter Creek	1740	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-23.858	53.410
29-Nov-05	Slaughter Creek	1420	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-14.164	6.670
31-Aug-05	Driskill	1228	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	2.023	12.950	-26.644	46.400
23-Aug-05	Genesis	1086	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	2.880	10.981	-22.350	38.775
30-May-06	Genesis	1839	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism	7.747	12.620	-21.537	47.470
21-Nov-05	Genesis	1364	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-23.387	41.870

21-Nov-05	Genesis	1365	unidentified Collembolan	Springtail	unidentified Collembolan	Collembola	Organism			-22.065	20.510
30-May-06	Surprise Sink	1893	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	2.761	9.494	-22.670	49.129
6-Nov-05	Blowing Sink	1250	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	2.855	9.359	-21.566	48.728
14-Feb-06	Surprise Sink	1566	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	3.603	10.500	-17.778	52.960
15-Nov-05	Surprise Sink	1316	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	3.664	10.970	-22.928	
8-Sep-05	Surprise Sink	1246	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	3.784	8.421	-20.973	52.578
15-Nov-05	Surprise Sink	1316	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	3.905	11.210	-22.311	
8-Sep-05	Surprise Sink	1247	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.013	9.348	-20.959	52.459
8-Sep-05	Surprise Sink	1249	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.013	9.425	-21.157	51.918
8-Sep-05	Surprise Sink	1248	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.127	9.893	-20.948	52.672
8-Sep-05	Surprise Sink	1245	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.262	10.009	-20.992	52.309
2-Feb-06	Blowing Sink	1473	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.653	11.020	-18.146	56.620
15-May-06	Blowing Sink	1927	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.845	10.872	-23.975	49.024
16-Nov-05	Bone Pile	1338	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.105	10.220	-22.416	49.050
8-Sep-05	Bone Pile	1234	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.106	8.860	-24.983	52.620
8-Sep-05	Bone Pile	1233	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.275	8.970	-23.414	51.310
8-Sep-05	Bone Pile	1235	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.310	8.660	-25.076	51.210
8-Sep-05	Blowing Sink	1230	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.317	9.790	-21.750	51.890
8-Sep-05	Bone Pile	1232	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.372	9.640	-24.537	47.030
8-Sep-05	Blowing Sink	1230	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.476	9.650	-21.741	50.790
8-Sep-05	Bone Pile	1231	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.610	9.790	-19.041	47.560
30-May-06	Bone Pile	1818	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.878	9.610	-23.182	51.740
14-Feb-06	Bone Pile	1505	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	6.496	11.040	-23.639	59.050
14-Feb-06	Bone Pile	1505	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	6.553	10.770	-23.551	56.430
24-May-06	Slaughter Creek	1746	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	3.719	10.340	-23.665	49.190
24-May-06	Slaughter Creek	1746	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	3.762	10.970	-23.701	50.810
22-May-06	Lost Oasis	1674	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	3.773	11.100	-21.524	55.760
29-Nov-05	Slaughter Creek	1419	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.045	10.780	-20.580	54.180
24-May-06	La Crosse	1706	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.435	9.340	-23.768	56.050
8-Sep-05	Lost Oasis	1243	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.692	11.050	-21.119	49.980
28-Feb-06	Lost Oasis	1628	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.724	10.550	-17.809	48.960
23-Nov-05	La Crosse	1397	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.793	7.650	-15.115	45.720
16-Feb-06	Slaughter Creek	1583	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.824	10.920	-21.858	49.280
8-Sep-05	Slaughter Creek	1244	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.922	10.010	-19.464	49.040
23-Nov-05	La Crosse	1397	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	4.924	9.230	-15.171	49.560
28-Feb-06	Lost Oasis	1628	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.070	11.120	-18.116	50.590
8-Sep-05	La Crosse	1242	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.298	8.540	-22.898	51.510
8-Nov-05	Lost Oasis	1284	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.353	11.300	-18.744	
23-Feb-06	La Crosse	1600	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.398	9.700	-20.348	47.250
8-Sep-05	Genesis	1239	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.501	7.100	-17.926	37.750
8-Sep-05	Genesis	1237	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.560	9.000	-17.887	46.190
8-Sep-05	Genesis	1238	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.698	7.630	-18.218	39.270
8-Sep-05	Genesis	1240	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.744	9.460	-17.923	50.020
8-Sep-05	Genesis	1241	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.752	8.470	-17.641	45.130
14-Feb-06	Genesis	1526	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	5.841	9.900	-14.637	52.870
30-May-06	Genesis	1840	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	6.156	10.590	-22.879	51.190
30-May-06	Genesis	1840	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	6.259	11.040	-22.832	50.030
25-May-06	Driskill	1782	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	7.305	7.870	-21.077	61.360
23-Feb-06	Driskill	1592	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	8.098	9.090	-22.896	52.950
28-Feb-06	Academy	1606	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	8.427	9.830	-19.217	48.890
30-Nov-05	Academy	1427	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	8.487	10.040	-	-
8-Sep-05	Driskill	1236	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism	8.495	9.120	-18.356	53.570
8-Sep-05	Academy	1229	Solenopsis invicta	Red Imported Fire Ant	Formicidae	Hymenoptera	Organism			-21.487	30.560
23-Nov-05	La Crosse	1391	Porcellio sp.	woodlouse	Porcellionidae	Isopoda	Organism	6.164	5.970	-21.191	34.930
23-Nov-05	La Crosse	1393	Porcellio sp.	woodlouse	Porcellionidae	Isopoda	Organism	6.898	5.760	-20.437	28.210
23-Nov-05	La Crosse	1392	Porcellio sp.	woodlouse	Porcellionidae	Isopoda	Organism	7.582	6.070	-22.970	36.480
15-Nov-05	Surprise Sink	1291	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	5.040	7.730	-21.265	
16-Nov-05	Bone Pile	1329	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	5.336	6.500	-22.337	35.440
16-Nov-05	Bone Pile	1327	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	5.412	6.740	-22.386	31.650

16-Nov-05	Bone Pile	1328	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	5.666	6.250	-21.189	31.410
16-Nov-05	Bone Pile	1326	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	5.961	5.430	-22.566	34.040
16-Nov-05	Bone Pile	1330	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	5.983	7.150	-22.316	37.910
15-Nov-05	Surprise Sink	1290	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	7.001	6.850	-21.301	
16-Nov-05	Bone Pile	1331	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	7.180	5.900	-21.283	29.710
14-Feb-06	Surprise Sink	1532	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	7.246	6.540	-22.862	34.140
21-Nov-05	Genesis	1349	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	3.817	6.150	-21.001	31.040
14-Feb-06	Genesis	1517	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	4.078	5.280	-21.324	26.690
23-Aug-05	Genesis	1075	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	4.100	6.528	-21.010	35.061
21-Nov-05	Genesis	1347	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	4.489	5.570	-20.646	31.350
21-Nov-05	Genesis	1348	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	4.659	6.040	-20.105	34.460
23-Aug-05	Genesis	1076	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	5.650	6.723	-20.720	32.516
25-May-06	Academy	1758	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	6.530	6.190	-19.994	35.690
25-May-06	Academy	1757	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	7.460	6.060	-19.582	33.000
21-Nov-05	Genesis	1350	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	7.925	5.330	-22.431	37.860
25-May-06	Academy	1760	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	9.103	5.800	-22.228	37.820
26-Aug-05	Academy	1191	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism	9.722	5.700	-20.204	36.460
25-May-06	Academy	1759	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism			-20.458	36.710
14-Feb-06	Genesis	1516	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism			-22.617	27.680
21-Nov-05	Genesis	1352	Brackenridgia sp.	terrestrial cave isopod	Trichoniscidae	Isopoda	Organism			-20.503	27.890
26-Aug-05	La Crosse	1140	unidentified isopod	unidentified isopod	unidentified isopod	Isopoda	Organism	11.796	6.000	-19.808	30.600
26-Aug-05	La Crosse	1138	unidentified isopod	unidentified isopod	unidentified isopod	Isopoda	Organism	12.228	6.810	-20.167	33.550
26-Aug-05	La Crosse	1137	unidentified isopod	unidentified isopod	unidentified isopod	Isopoda	Organism	12.949	6.000	-19.284	30.670
26-Aug-05	La Crosse	1136	unidentified isopod	unidentified isopod	unidentified isopod	Isopoda	Organism	13.201	6.520	-16.975	30.820
26-Aug-05	La Crosse	1139	unidentified isopod	unidentified isopod	unidentified isopod	Isopoda	Organism			-20.862	23.280
23-Aug-05	Bone Pile	1117	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	-0.010	9.284	-24.760	51.207
30-May-06	Surprise Sink	1888	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	0.685	9.962	-23.660	46.702
30-May-06	Bone Pile	1815	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	0.845	8.350	-23.996	49.600
30-May-06	Surprise Sink	1888	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	0.849	9.912	-23.744	47.380
30-May-06	Surprise Sink	1891	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.185	8.189	-24.132	46.611
30-May-06	Bone Pile	1814	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.372	7.290	-24.558	53.290
23-Aug-05	Bone Pile	1118	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.440	9.103	-24.670	48.775
30-May-06	Bone Pile	1817	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.475	10.270	-23.790	50.440
23-Aug-05	Bone Pile	1119	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.490	9.960	-24.830	52.595
23-Aug-05	Bone Pile	1119	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.700	9.680	-24.910	52.838
30-May-06	Surprise Sink	1892	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.742	9.287	-24.487	52.381
30-May-06	Bone Pile	1813	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.768	8.130	-24.538	55.230
30-May-06	Surprise Sink	1889	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.816	9.428	-23.985	47.677
30-May-06	Bone Pile	1813	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	1.934	8.250	-24.574	56.870
23-Aug-05	Bone Pile	1116	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	2.420	10.515	-25.040	51.499
16-Nov-05	Bone Pile	1337	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	2.470	9.180	-24.489	46.980
15-May-06	Blowing Sink	1911	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	2.805	8.512	-25.021	49.423
15-May-06	Blowing Sink	1905	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.030	8.822	-24.663	50.956
30-May-06	Surprise Sink	1890	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.170	7.277	-25.285	52.976
15-May-06	Blowing Sink	1901	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.304	10.000	-24.588	44.789
30-May-06	Bone Pile	1816	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.515	9.580	-24.435	46.630
15-May-06	Blowing Sink	1902	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.642	8.228	-24.980	49.858
15-May-06	Blowing Sink	1906	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.961	8.359	-24.971	53.326
31-Aug-05	Blowing Sink	1216	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.072	8.220	-25.555	54.190
31-Aug-05	Blowing Sink	1218	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.175	9.090	-25.284	49.170
31-Aug-05	Blowing Sink	1217	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.485	8.880	-25.060	50.810
31-Aug-05	Blowing Sink	1220	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.593	15.660		
31-Aug-05	Blowing Sink	1219	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.904	6.870	-26.035	51.990
24-May-06	Slaughter Creek	1749	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	2.571	9.080	-24.335	49.180
24-May-06	Slaughter Creek	1748	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	2.825	9.510	-24.196	49.380
24-May-06	Slaughter Creek	1748	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	2.957	9.300	-24.074	47.630
24-May-06	Slaughter Creek	1747	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.012	10.570	-23.759	48.960
24-May-06	La Crosse	1702	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.289	8.330	-24.696	50.970
24-May-06	Slaughter Creek	1751	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.364	7.120	-25.519	52.270
22-May-06	Lost Oasis	1672	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.385	9.610	-23.935	51.810

31-Aug-05	Slaughter Creek	1176	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.428	10.680	-24.693	51.450
31-Aug-05	Slaughter Creek	1178	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.464	11.040	-24.138	53.060
24-May-06	Slaughter Creek	1750	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.475	9.380	-24.671	49.430
22-May-06	Lost Oasis	1672	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.486	9.380	-23.893	51.810
31-Aug-05	Slaughter Creek	1179	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.661	10.990	-24.289	52.010
22-May-06	Lost Oasis	1670	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.785	7.750	-25.633	56.500
22-May-06	Lost Oasis	1671	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.885	8.260	-24.410	53.560
26-Aug-05	La Crosse	1143	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.966	10.850	-26.972	52.850
26-Aug-05	La Crosse	1144	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	3.990	10.030	-25.830	53.240
24-May-06	La Crosse	1704	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.107	8.310	-25.442	57.440
24-May-06	La Crosse	1703	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.125	8.690	-25.355	55.370
22-May-06	Lost Oasis	1673	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.209	15.460	-23.824	71.930
24-May-06	La Crosse	1703	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.263	8.570	-25.434	54.520
26-Aug-05	La Crosse	1141	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.396	8.470	-26.995	55.670
24-May-06	La Crosse	1705	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.452	8.290	-25.043	56.270
22-May-06	Lost Oasis	1669	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.669	7.640	-25.827	55.400
24-May-06	La Crosse	1701	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.790	8.960	-25.182	60.690
31-Aug-05	Slaughter Creek	1177	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.798	10.040	-24.624	52.700
31-Aug-05	Slaughter Creek	1175	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.841	10.280	-25.298	55.240
31-Aug-05	Slaughter Creek	1175	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.921	10.180	-25.136	54.700
26-Aug-05	La Crosse	1145	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	5.075	8.280	-26.621	57.740
23-Nov-05	La Crosse	1390	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	5.651	10.770	-24.505	48.190
23-Nov-05	La Crosse	1390	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	5.874	10.580	-24.400	47.580
23-Aug-05	Genesis	1093	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.920	10.166	-24.740	49.364
23-Aug-05	Genesis	1094	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	4.980	10.501	-24.400	48.699
23-Aug-05	Genesis	1091	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	5.620	10.810	-25.050	48.952
23-Aug-05	Genesis	1090	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	6.130	9.596	-24.620	47.878
23-Aug-05	Genesis	1092	Leiobunum townsendii	DaddyLong-Legs	Phalangiidae	Opiliones	Organism	6.273	10.808	-23.935	48.913
28-Jul-05	Surprise Sink	1025	unidentified harvestman	unidentified harvestman	unidentified harvestman	Opiliones	Organism	1.600	9.400	-25.530	46.780
28-Jul-05	Surprise Sink	1027	unidentified harvestman	unidentified harvestman	unidentified harvestman	Opiliones	Organism	1.700	9.160	-25.450	49.750
28-Jul-05	Surprise Sink	1028	unidentified harvestman	unidentified harvestman	unidentified harvestman	Opiliones	Organism	2.200	8.950	-25.550	52.900
28-Jul-05	Surprise Sink	1026	unidentified harvestman	unidentified harvestman	unidentified harvestman	Opiliones	Organism	2.500	9.010	-25.570	49.540
28-Jul-05	Surprise Sink	1029	unidentified harvestman	unidentified harvestman	unidentified harvestman	Opiliones	Organism	3.120	7.890	-25.310	51.540
17-Aug-05	Lost Oasis	1070	unidentified harvestman	unidentified harvestman	unidentified harvestman	Opiliones	Organism	4.430	9.928	-25.420	47.236
23-Nov-05	La Crosse	1388	unidentified harvestman	unidentified harvestman	unidentified harvestman	Opiliones	Organism	5.477	9.270	-25.156	50.320
23-Nov-05	La Crosse	1389	unidentified harvestman	unidentified harvestman	unidentified harvestman	Opiliones	Organism			-24.595	48.350
14-Feb-06	Bone Pile	1484	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.755	12.280	-22.216	50.890
15-Nov-05	Surprise Sink	1295	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.241	9.730	-21.089	
23-Aug-05	Bone Pile	1107	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.700	11.011	-24.060	47.120
23-Aug-05	Bone Pile	1110	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.740	10.762	-23.890	46.134
23-Aug-05	Bone Pile	1106	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.980	11.854	-23.570	46.680
23-Aug-05	Bone Pile	1103	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.080	10.837	-24.390	53.713
23-Aug-05	Bone Pile	1104	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.180	11.835	-24.220	51.609
23-Aug-05	Bone Pile	1108	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.320	11.905	-23.900	48.444
23-Aug-05	Bone Pile	1105	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.390	11.205	-23.750	46.454
6-Nov-05	Blowing Sink	1257	Ceuthophilus (G.)	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.529	11.658	-22.051	43.789

			cunicularis								
23-Aug-05	*Bone Pile*	*1109*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.020*	*10.006*	*-24.750*	*54.801*
15-Nov-05	*Surprise Sink*	*1296*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.073*	*10.580*	*-22.681*	
15-Nov-05	*Surprise Sink*	*1298*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.141*	*11.310*	*-22.620*	
6-Nov-05	*Blowing Sink*	*1261*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.292*	*10.360*	*-22.812*	*43.327*
6-Nov-05	*Blowing Sink*	*1260*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.296*	*9.984*	*-23.381*	*44.386*
6-Nov-05	*Blowing Sink*	*1258*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.367*	*11.414*	*-22.246*	*46.417*
16-Nov-05	*Bone Pile*	*1448*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.387*	*10.920*	*-23.319*	*47.170*
31-Aug-05	*Blowing Sink*	*1210*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.453*	*10.630*	*-22.381*	*45.550*
15-Nov-05	*Surprise Sink*	*1299*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.455*	*10.120*	*-23.244*	
15-Nov-05	*Surprise Sink*	*1297*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.526*	*11.500*	*-22.698*	
16-Nov-05	*Bone Pile*	*1446*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.662*	*9.930*	*-23.168*	*45.820*
16-Nov-05	*Bone Pile*	*1444*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.684*	*10.330*	*-23.485*	*47.770*
16-Nov-05	*Bone Pile*	*1445*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.730*	*10.590*	*-23.255*	*47.090*
16-Nov-05	*Bone Pile*	*1444*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.777*	*9.750*	*-23.318*	*45.050*
15-Nov-05	*Surprise Sink*	*1297*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.792*	*11.330*	*-22.715*	
16-Nov-05	*Bone Pile*	*1447*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*4.907*	*11.840*	*-23.089*	*50.730*
6-Nov-05	*Blowing Sink*	*1259*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.305*	*10.685*	*-21.776*	*47.295*
31-Aug-05	*Blowing Sink*	*1209*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.649*	*10.320*	*-22.380*	*52.320*
2-Feb-06	*Blowing Sink*	*1465*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.825*	*10.410*	*-21.662*	*41.860*
31-Aug-05	*Blowing Sink*	*1208*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*6.445*	*11.930*	*-23.241*	*50.500*
28-Feb-06	*Lost Oasis*	*1616*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*1.761*	*6.880*	*-24.927*	*49.330*
28-Feb-06	*Lost Oasis*	*1617*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.138*	*13.210*	*-21.419*	*44.870*
8-Nov-05	*Lost Oasis*	*1436*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.180*	*9.250*	*-23.353*	*43.620*
29-Nov-05	*Slaughter Creek*	*1459*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.264*	*10.370*	*-22.299*	*47.130*
28-Feb-06	*Lost Oasis*	*1617*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.268*	*13.120*	*-21.541*	*44.760*
8-Nov-05	*Lost Oasis*	*1438*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.569*	*12.000*	*-22.556*	*46.760*
8-Nov-05	*Lost Oasis*	*1437*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.581*	*10.870*	*-22.856*	*46.850*
8-Nov-05	*Lost Oasis*	*1435*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.614*	*10.270*	*-22.996*	*47.280*
8-Nov-05	*Lost Oasis*	*1434*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.622*	*10.410*	*-23.255*	*45.600*
31-Aug-05	*Slaughter Creek*	*1169*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*5.730*	*12.140*	*-21.567*	*48.660*
16-Feb-06	*Slaughter Creek*	*1575*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*6.276*	*10.060*	*-22.574*	*49.990*
23-Nov-05	*La Crosse*	*1373*	*Ceuthophilus (G.) cunicularis*	*Cave Cricket*	*Rhaphidophoridae*	*Orthoptera*	*Organism*	*6.437*	*10.630*	*-22.399*	*44.270*

23-Nov-05	La Crosse	1373	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	6.504	10.920	-22.007	44.350
31-Aug-05	Slaughter Creek	1168	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	6.556	11.250	-22.927	50.220
31-Aug-05	Slaughter Creek	1167	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	6.858	10.530	-21.084	48.980
23-Nov-05	La Crosse	1371	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	7.058	11.200	-21.686	43.440
31-Aug-05	Slaughter Creek	1166	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	7.297	12.470	-22.373	48.570
31-Aug-05	Slaughter Creek	1166	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	7.421	12.310	-22.301	48.330
23-Nov-05	La Crosse	1372	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	13.052	11.370	-18.674	40.280
21-Nov-05	Genesis	1642	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.123	10.060	-23.622	46.460
21-Nov-05	Genesis	1641	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.221	11.150	-21.873	46.540
23-Aug-05	Genesis	1087	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.800	10.337	-22.680	45.693
14-Feb-06	Genesis	1523	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.010	10.620	-22.656	44.350
23-Aug-05	Genesis	1089	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.430	11.153	-23.510	44.758
21-Nov-05	Genesis	1639	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	6.282	10.590	-22.118	47.000
21-Nov-05	Genesis	1640	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	7.137	11.180	-21.074	45.490
23-Aug-05	Genesis	1088	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	8.110	8.859	-23.850	42.211
26-Aug-05	Academy	1196	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	9.508	10.210	-21.500	46.120
26-Aug-05	Academy	1195	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	10.406	10.340	-22.146	50.780
26-Aug-05	Academy	1195	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	10.999	10.450	-21.887	50.590
30-May-06	Surprise Sink	1865	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.660	7.990	-23.273	47.540
30-May-06	Surprise Sink	1863	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.030	12.640	-22.357	43.540
30-May-06	Bone Pile	1796	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.149	9.520	-22.260	47.600
14-Feb-06	Surprise Sink	1537	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.526	10.840	-22.228	44.480
30-May-06	Surprise Sink	1866	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.746	12.020	-22.759	45.670
30-May-06	Surprise Sink	1861	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.858	11.670	-22.280	41.380
30-May-06	Surprise Sink	1864	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.913	12.140	-21.983	43.740
15-May-06	Blowing Sink	1909	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.179	11.909	-23.173	43.574
30-May-06	Surprise Sink	1862	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.209	11.950	-22.367	43.130
30-May-06	Bone Pile	1798	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.335	10.890	-22.156	47.430
30-May-06	Bone Pile	1797	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.535	10.550	-21.514	46.470
15-May-06	Blowing Sink	1916	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.326	9.984	-23.192	42.932
15-May-06	Blowing Sink	1916	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.335	9.762	-23.235	41.919
15-May-06	Blowing Sink	1917	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.656	11.210	-21.809	43.466
15-May-06	Blowing Sink	1910	Ceuthophilus (G.)	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.933	9.105	-22.804	38.937

			cunicularis								
15-May-06	Blowing Sink	1909	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	6.934	10.766	-21.731	36.778
24-May-06	Slaughter Creek	1715	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.429	6.860	-22.244	42.760
24-May-06	Slaughter Creek	1716	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.976	10.170	-22.491	49.820
25-May-06	Driskill	1778	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	8.682	10.440	-23.093	43.690
25-May-06	Driskill	1778	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	8.901	10.610	-22.939	45.230
25-May-06	Academy	1762	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	9.854	9.200	-23.936	49.460
25-May-06	Academy	1763	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	10.211	11.130	-22.863	45.960
25-May-06	Academy	1761	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	12.592	8.630	-22.765	43.040
25-May-06	Academy	1761	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	12.773	8.570	-22.738	42.890
14-Feb-06	Surprise Sink	1540	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	-0.153	8.020	-22.495	53.600
30-May-06	Surprise Sink	1870	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.021	13.690	-22.242	44.350
30-May-06	Bone Pile	1799	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.189	8.860	-22.950	49.490
30-May-06	Surprise Sink	1871	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.453	13.770	-22.040	45.180
14-Feb-06	Surprise Sink	1539	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.495	9.610	-22.346	42.550
14-Feb-06	Surprise Sink	1541	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.527	10.340	-22.528	45.560
30-May-06	Surprise Sink	1868	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.557	15.030	-21.624	44.870
30-May-06	Surprise Sink	1868	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.652	14.450	-21.720	44.230
15-May-06	Blowing Sink	1903	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.993	9.966	-22.072	41.033
14-Feb-06	Surprise Sink	1538	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.039	10.810	-22.918	46.290
30-May-06	Bone Pile	1801	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.134	10.960	-21.838	46.280
30-May-06	Surprise Sink	1869	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.440	13.110	-21.577	42.630
30-May-06	Bone Pile	1800	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.450	11.111	-21.927	44.450
30-May-06	Surprise Sink	1867	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.633	12.380	-22.049	42.200
14-Feb-06	Bone Pile	1483	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.948	11.580	-22.958	51.790
15-May-06	Blowing Sink	1920	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.364	11.114	-22.255	42.989
24-May-06	La Crosse	1685	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.881	5.290	-27.371	49.070
24-May-06	Slaughter Creek	1717	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.161	9.140	-22.117	45.730
24-May-06	Slaughter Creek	1718	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.395	9.820	-21.939	49.860
24-May-06	Slaughter Creek	1719	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	7.586	10.860	-21.922	47.790
24-May-06	Slaughter Creek	1719	Ceuthophilus (G.) cunicularis	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	7.875	10.320	-22.088	45.810
23-Aug-05	Bone Pile	1114	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.490	10.405	-24.820	52.551
15-Nov-05	Surprise Sink	1301	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.868	7.320	-22.511	

15-Nov-05	Surprise Sink	1305	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.101	11.960	-23.851	
15-Nov-05	Surprise Sink	1305	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.118	12.040	-23.475	
15-Nov-05	Surprise Sink	1304	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.309	10.280	-22.962	
15-Nov-05	Surprise Sink	1303	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.348	10.510	-24.172	
23-Aug-05	Bone Pile	1111	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.430	9.979	-25.300	50.345
23-Aug-05	Bone Pile	1113	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.440	10.926	-25.010	50.872
15-Nov-05	Surprise Sink	1306	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.505	11.070	-23.331	
23-Aug-05	Bone Pile	1111	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.540	9.912	-24.930	46.493
14-Feb-06	Bone Pile	1490	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.622	9.730	-19.095	55.540
6-Nov-05	Blowing Sink	1253	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.706	7.808	-23.506	52.522
15-Nov-05	Surprise Sink	1302	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.977	11.570	-23.303	
23-Aug-05	Bone Pile	1115	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.020	9.381	-24.400	51.780
14-Feb-06	Bone Pile	1491	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.054	10.600	-24.058	55.930
2-Feb-06	Blowing Sink	1467	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.105	10.280	-21.992	53.520
15-Nov-05	Surprise Sink	1300	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.157	10.500	-23.818	
2-Feb-06	Blowing Sink	1468	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.477	11.060	-20.784	52.490
23-Aug-05	Bone Pile	1112	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.520	9.859	-25.560	53.439
6-Nov-05	Blowing Sink	1255	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.614	9.717	-23.421	49.970
31-Aug-05	Blowing Sink	1212	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.726	5.740	-25.356	48.110
31-Aug-05	Blowing Sink	1213	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.890	9.210	-23.937	50.300
2-Feb-06	Blowing Sink	1469	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.900	10.150	-21.649	52.740
2-Feb-06	Blowing Sink	1470	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.161	9.380	-18.613	53.380
2-Feb-06	Blowing Sink	1466	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.421	11.430	-24.120	48.350
6-Nov-05	Blowing Sink	1256	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.432	11.129	-23.957	47.217
31-Aug-05	Blowing Sink	1211	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.466	9.480	-22.631	47.880
31-Aug-05	Blowing Sink	1214	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.043	11.020	-23.573	51.750
31-Aug-05	Blowing Sink	1214	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.067	10.860	-23.528	49.560
6-Nov-05	Blowing Sink	1254	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.245	11.261	-22.342	48.382
2-Feb-06	Blowing Sink	1471	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.680	12.880	-19.711	51.330
2-Feb-06	Blowing Sink	1471	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.695	12.540	-19.566	50.180
2-Feb-06	Blowing Sink	1472	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.466	13.060	-22.067	49.530
29-Nov-05	Slaughter Creek	1461	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.348	8.410	-21.725	46.230
16-Feb-06	Slaughter Creek	1578	Ceuthophilus (C.)	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.641	9.470	-24.134	47.570

			secretus								
16-Feb-06	Slaughter Creek	1576	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.669	6.470	-19.844	47.190
8-Nov-05	Lost Oasis	1439	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.722	9.670	-26.166	52.840
28-Feb-06	Lost Oasis	1623	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.868	7.500	-23.637	47.560
29-Nov-05	Slaughter Creek	1464	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.930	8.300	-15.614	44.580
8-Nov-05	Lost Oasis	1441	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.017	9.980	-25.808	50.710
28-Feb-06	Lost Oasis	1620	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.035	11.480	-21.368	48.700
29-Nov-05	Slaughter Creek	1460	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.096	9.610	-24.385	51.110
8-Nov-05	Lost Oasis	1443	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.190	9.770	-20.939	49.060
28-Feb-06	Lost Oasis	1618	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.317	9.510	-19.019	48.140
28-Feb-06	Lost Oasis	1621	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.346	8.400	-22.890	50.990
28-Feb-06	Lost Oasis	1619	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.439	11.550	-22.654	47.260
8-Nov-05	Lost Oasis	1442	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.443	8.640	-21.995	54.690
26-Aug-05	La Crosse	1132	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.580	13.049	-23.390	47.590
23-Feb-06	La Crosse	1598	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.865	11.340	-21.420	46.950
8-Nov-05	Lost Oasis	1440	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.898	11.950	-21.041	47.370
23-Feb-06	La Crosse	1598	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.916	11.280	-21.350	46.230
29-Nov-05	Slaughter Creek	1463	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.027	10.960	-23.105	48.750
31-Aug-05	Slaughter Creek	1170	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.441	8.820	-26.020	51.170
29-Nov-05	Slaughter Creek	1462	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.464	9.490	-21.890	49.850
29-Nov-05	Slaughter Creek	1462	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.727	9.730	-21.923	49.930
31-Aug-05	Slaughter Creek	1171	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.750	12.400	-23.590	54.240
26-Aug-05	La Crosse	1134	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.809	12.070	-23.998	50.620
26-Aug-05	La Crosse	1133	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.820	11.513	-25.130	50.145
31-Aug-05	Slaughter Creek	1172	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.871	11.180	-25.368	53.000
31-Aug-05	Slaughter Creek	1174	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.984	11.210	-23.966	51.990
16-Feb-06	Slaughter Creek	1577	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.161	9.160	-21.728	45.650
31-Aug-05	Slaughter Creek	1173	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.175	11.870	-24.488	52.190
28-Feb-06	Lost Oasis	1622	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.416	11.380	-23.449	50.780
14-Feb-06	Genesis	1525	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.773	9.500	-23.313	50.220
14-Feb-06	Genesis	1524	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.287	8.460	-22.435	52.930
14-Feb-06	Bone Pile	1486	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.118	6.530	-23.053	52.030
16-Nov-05	Bone Pile	1453	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.223	7.330	-24.367	58.710

14-Feb-06	Bone Pile	1486	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.281	6.700	-23.035	51.160
14-Feb-06	Surprise Sink	1545	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.561	7.680	-19.348	55.640
14-Feb-06	Surprise Sink	1546	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.673	6.970	-23.355	49.360
30-May-06	Surprise Sink	1873	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.742	6.989	-24.241	47.647
16-Nov-05	Bone Pile	1450	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.828	9.820	-24.104	51.340
14-Feb-06	Surprise Sink	1542	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.916	6.560	-22.635	52.130
30-May-06	Surprise Sink	1875	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.922	7.664	-25.194	48.774
16-Nov-05	Bone Pile	1449	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.015	11.280	-23.833	53.910
14-Feb-06	Surprise Sink	1547	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.127	8.260	-21.506	49.050
16-Nov-05	Bone Pile	1451	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.330	10.260	-23.985	55.190
30-May-06	Bone Pile	1806	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.340	8.690	-23.349	51.160
30-May-06	Surprise Sink	1872	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.342	11.470	-23.494	48.460
14-Feb-06	Surprise Sink	1544	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.414	9.490	-17.825	52.170
14-Feb-06	Bone Pile	1487	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.431	10.180	-21.544	57.120
30-May-06	Bone Pile	1805	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.781	11.190	-22.332	51.090
30-May-06	Bone Pile	1803	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.896	6.450	-23.476	52.390
15-May-06	Blowing Sink	1904	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.909	5.398	-23.877	46.933
14-Feb-06	Surprise Sink	1543	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.969	9.260	-21.695	51.590
14-Feb-06	Surprise Sink	1543	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.999	9.020	-21.792	50.580
30-May-06	Bone Pile	1802	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.012	9.350	-23.693	55.100
30-May-06	Surprise Sink	1874	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.150	9.942	-23.679	45.172
15-May-06	Blowing Sink	1900	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.242	9.450	-22.300	48.781
30-May-06	Bone Pile	1803	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.350	7.060	-23.388	49.330
16-Nov-05	Bone Pile	1452	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.440	9.650	-23.546	57.960
16-Nov-05	Bone Pile	1452	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.501	10.340	-22.973	62.050
14-Feb-06	Bone Pile	1485	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.748	11.750	-23.989	52.520
15-May-06	Blowing Sink	1921	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.774	6.064	-24.668	49.658
15-May-06	Blowing Sink	1899	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.798	6.259	-23.945	48.038
30-May-06	Bone Pile	1804	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.855	12.220	-22.888	47.720
15-May-06	Blowing Sink	1899	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.069	5.767	-23.961	44.950
15-May-06	Blowing Sink	1912	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.087	12.292	-23.130	43.222
24-May-06	La Crosse	1688	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.564	4.840	-23.167	49.990
24-May-06	Slaughter Creek	1721	Ceuthophilus (C.)	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.306	8.190	-24.562	58.470

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24-May-06	Slaughter Creek	1725	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.411	6.610	-23.913	47.940
24-May-06	Slaughter Creek	1720	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.486	8.410	-23.630	53.510
24-May-06	Slaughter Creek	1726	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.504	10.070	-23.300	51.740
24-May-06	La Crosse	1691	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.542	8.670	-23.863	56.730
24-May-06	Slaughter Creek	1723	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.560	8.270	-22.891	54.950
22-May-06	Lost Oasis	1663	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.646	10.490	-23.568	47.260
24-May-06	Slaughter Creek	1724	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.754	8.770	-23.955	52.190
24-May-06	Slaughter Creek	1722	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.895	7.730	-21.359	53.820
22-May-06	Lost Oasis	1662	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.286	8.670	-21.750	52.810
24-May-06	La Crosse	1690	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.341	7.830	-24.108	51.080
24-May-06	La Crosse	1692	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.544	9.390	-24.091	56.650
22-May-06	Lost Oasis	1661	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.781	9.100	-24.038	55.960
24-May-06	La Crosse	1689	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.963	10.220	-21.656	47.870
24-May-06	La Crosse	1693	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.057	12.220	-21.922	52.960
24-May-06	La Crosse	1693	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.142	11.720	-21.868	51.210
30-May-06	Bone Pile	1808	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	-0.227	7.700	-23.384	54.860
30-May-06	Surprise Sink	1878	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.116	7.667	-24.775	48.127
30-May-06	Surprise Sink	1877	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.543	6.344	-23.625	47.162
30-May-06	Surprise Sink	1877	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.666	5.619	-23.639	45.674
30-May-06	Surprise Sink	1881	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.865	8.017	-24.122	51.681
30-May-06	Surprise Sink	1880	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.098	6.228	-23.599	48.005
30-May-06	Bone Pile	1809	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.320	8.310	-23.995	51.640
14-Feb-06	Bone Pile	1489	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.513	11.280	-22.299	55.900
30-May-06	Bone Pile	1810	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.673	8.260	-24.129	53.840
30-May-06	Surprise Sink	1879	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.717	7.770	-23.772	49.341
30-May-06	Bone Pile	1807	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.896	10.990	-23.298	50.130
14-Feb-06	Bone Pile	1488	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.110	8.880	-23.459	55.530
15-May-06	Blowing Sink	1918	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.155	8.401	-24.203	54.245
30-May-06	Bone Pile	1811	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.328	9.510	-23.251	47.720
15-May-06	Blowing Sink	1915	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.029	11.635	-22.972	47.166
15-May-06	Blowing Sink	1919	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.449	5.675	-25.523	43.731
15-May-06	Blowing Sink	1913	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.875	10.860	-22.518	43.029

24-May-06	Slaughter Creek	1728	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.189	8.740	-23.454	54.590
24-May-06	Slaughter Creek	1727	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.232	9.160	-24.216	49.450
24-May-06	Slaughter Creek	1728	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.334	7.760	-23.739	52.730
22-May-06	Lost Oasis	1664	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.695	7.920	-23.827	52.070
24-May-06	La Crosse	1686	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.758	10.370	-23.636	50.880
22-May-06	Lost Oasis	1666	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.067	10.660	-23.329	61.160
22-May-06	Lost Oasis	1664	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.079	8.040	-23.823	48.740
22-May-06	Lost Oasis	1668	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.336	10.690	-24.060	52.770
22-May-06	Lost Oasis	1667	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.480	10.450	-23.810	51.440
22-May-06	Lost Oasis	1665	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.573	10.710	-23.594	56.310
24-May-06	La Crosse	1687	Ceuthophilus (C.) secretus	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.597	9.280	-20.966	52.270
16-Nov-05	Bone Pile	1454	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.034	8.820	-23.832	53.910
14-Feb-06	Bone Pile	1503	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.044	10.350	-20.494	55.820
16-Nov-05	Bone Pile	1457	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.393	9.490	-21.748	51.230
15-Nov-05	Surprise Sink	1309	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.486	9.230	-22.219	
15-Nov-05	Surprise Sink	1308	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.538	8.550	-21.970	
16-Nov-05	Bone Pile	1458	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.702	8.220	-24.156	52.620
15-Nov-05	Surprise Sink	1310	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.716	10.540	-22.428	
16-Nov-05	Bone Pile	1455	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.860	8.810	-24.348	50.520
15-Nov-05	Surprise Sink	1307	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.167	10.720	-22.710	
16-Nov-05	Bone Pile	1456	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.669	10.840	-23.907	49.460
31-Aug-05	Blowing Sink	1207	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.853	9.160	-23.401	54.280
31-Aug-05	Blowing Sink	1205	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.113	12.060	-23.259	54.280
31-Aug-05	Blowing Sink	1204	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.150	9.250	-23.222	54.910
31-Aug-05	Blowing Sink	1205	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.224	12.040	-23.152	52.590
31-Aug-05	Blowing Sink	1203	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.680	9.870	-24.430	55.500
31-Aug-05	Blowing Sink	1206	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.947	11.300	-21.325	55.160
23-Nov-05	La Crosse	1376	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.634	9.630	-23.416	47.530
16-Feb-06	Slaughter Creek	1579	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.043	7.290	-22.784	45.380
23-Nov-05	La Crosse	1380	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.660	8.160	-23.879	42.330
23-Nov-05	La Crosse	1374	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.684	9.730	-23.620	46.470
23-Nov-05	La Crosse	1378	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.810	9.700	-23.561	46.740
23-Nov-05	La Crosse	1379	Ceuthophilus (C.) species	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.054	9.970	-22.624	50.700

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23-Nov-05	La Crosse	1381	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.258	12.400	-22.137	47.380
23-Nov-05	La Crosse	1381	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.319	12.680	-22.131	48.680
23-Nov-05	La Crosse	1375	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.365	12.200	-23.366	46.690
23-Nov-05	La Crosse	1377	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.818	11.600	-22.707	48.060
23-Nov-05	La Crosse	1382	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.776	11.940	-20.414	48.590
14-Feb-06	Surprise Sink	1549	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.501	11.800	-21.395	52.500
14-Feb-06	Surprise Sink	1555	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.999	8.990	-19.939	57.600
14-Feb-06	Bone Pile	1496	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.036	11.730	-22.526	56.310
14-Feb-06	Bone Pile	1493	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.096	11.590	-22.086	54.610
30-May-06	Surprise Sink	1884	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.252	6.706	-25.014	56.822
14-Feb-06	Bone Pile	1498	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.264	8.620	-21.066	55.620
14-Feb-06	Surprise Sink	1559	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.301	10.240	-20.955	52.600
30-May-06	Surprise Sink	1885	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.417	6.335	-24.296	53.834
14-Feb-06	Bone Pile	1492	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.424	10.250	-23.310	55.680
30-May-06	Surprise Sink	1883	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.530	7.022	-23.674	49.929
14-Feb-06	Surprise Sink	1556	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.542	10.250	-21.549	51.080
14-Feb-06	Surprise Sink	1553	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.572	8.230	-17.681	49.890
30-May-06	Surprise Sink	1882	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.578	9.658	-20.343	46.894
14-Feb-06	Bone Pile	1497	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.581	9.100	-23.545	57.730
14-Feb-06	Surprise Sink	1553	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.643	8.370	-18.132	50.990
14-Feb-06	Surprise Sink	1554	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.722	7.660	-21.443	56.290
14-Feb-06	Surprise Sink	1551	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.800	11.500	-21.350	51.530
14-Feb-06	Surprise Sink	1558	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.893	8.520	-20.849	56.300
14-Feb-06	Bone Pile	1495	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.895	12.300	-22.284	52.770
30-May-06	Surprise Sink	1886	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.939	10.924	-21.572	44.986
14-Feb-06	Bone Pile	1499	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.013	8.900	-23.182	56.020
14-Feb-06	Surprise Sink	1557	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.083	9.420	-19.628	58.200
14-Feb-06	Surprise Sink	1560	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.308	9.550	-23.400	56.326
14-Feb-06	Bone Pile	1494	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.357	8.200	-23.873	61.300
14-Feb-06	Surprise Sink	1552	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.404	12.800	-21.707	49.910
14-Feb-06	Surprise Sink	1548	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.539	8.770	-23.439	35.670
14-Feb-06	Bone Pile	1494	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.596	8.580	-23.687	61.290

14-Feb-06	Surprise Sink	1550	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.657	10.900	-23.165	50.950
24-May-06	Slaughter Creek	1713	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.403	10.100	-22.119	56.010
24-May-06	Slaughter Creek	1712	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.563	9.060	-22.284	54.750
24-May-06	Slaughter Creek	1714	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.690	7.010	-22.545	52.470
14-Feb-06	Bone Pile	1501	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.053	10.580	-22.108	56.920
14-Feb-06	Bone Pile	1500	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.374	11.060	-23.404	57.700
14-Feb-06	Bone Pile	1502	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.787	10.640	-22.405	50.680
24-May-06	La Crosse	1681	Ceuthophilus (C.) species B	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.563	10.490	-23.085	52.110
28-Jul-05	Surprise Sink	1015	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.300	7.600	-23.330	45.440
28-Jul-05	Surprise Sink	1016	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	0.530	9.090	-24.570	51.970
28-Jul-05	Surprise Sink	1018	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.090	9.890	-24.890	52.560
28-Jul-05	Surprise Sink	1019	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.330	8.730	-25.850	48.110
28-Jul-05	Surprise Sink	1017	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.330	9.400	-25.080	57.190
28-Jul-05	Surprise Sink	1014	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.360	8.405	-24.885	52.745
28-Jul-05	Surprise Sink	1010	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.060	9.850	-24.620	52.020
28-Jul-05	Surprise Sink	1013	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.920	10.600	-24.390	52.980
28-Jul-05	Surprise Sink	1011	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.100	8.620	-24.680	54.200
28-Jul-05	Surprise Sink	1012	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.350	10.760	-26.140	49.870
17-Aug-05	Lost Oasis	1055	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.920	9.820	-25.300	51.430
17-Aug-05	Lost Oasis	1058	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.000	8.750	-26.130	50.380
17-Aug-05	Lost Oasis	1056	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.140	7.530	-25.710	35.410
17-Aug-05	Lost Oasis	1055	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.350	11.580	-24.860	50.600
17-Aug-05	Lost Oasis	1057	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.770	11.420	-23.940	46.380
17-Aug-05	Lost Oasis	1059	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.010	10.040	-25.520	46.860
26-Aug-05	La Crosse	1125	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.510	10.501	-26.660	53.323
17-Aug-05	Lost Oasis	1053	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.540	8.680	-25.120	50.970
17-Aug-05	Lost Oasis	1051	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.560	9.670	-24.300	47.320
26-Aug-05	La Crosse	1126	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.650	12.371	-24.440	49.997
17-Aug-05	Lost Oasis	1054	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.660	9.810	-24.480	42.430
17-Aug-05	Lost Oasis	1050	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.080	8.850	-25.230	48.070
17-Aug-05	Lost Oasis	1050	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.220	8.760	-25.480	49.600
17-Aug-05	Lost Oasis	1052	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.510	9.640	-24.260	42.400
23-Aug-05	Genesis	1083	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.130	9.573	-23.000	44.773
23-Aug-05	Genesis	1082	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	4.735	10.245	-24.545	46.494
24-May-06	La Crosse	1684	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.650	9.510	-23.231	51.590
24-May-06	La Crosse	1682	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.892	6.790	-24.604	45.950
24-May-06	La Crosse	1682	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	3.123	7.310	-24.377	45.500
24-May-06	La Crosse	1683	Ceuthphilus sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	5.812	12.180	-20.743	46.040
21-Nov-05	Genesis	1644	Ceuthophilus (C.) sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	1.917	9.750	-25.343	47.990
21-Nov-05	Genesis	1643	Ceuthophilus (C.) sp.	Cave Cricket	Rhaphidophoridae	Orthoptera	Organism	2.168	11.920	-23.851	48.500
16-Nov-05	Bone Pile	1343	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	0.480	5.160	-21.205	22.400
16-Nov-05	Bone Pile	1343	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	1.018	5.300	-21.990	23.820
30-May-06	Bone Pile	1819	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	1.576	5.810	-21.693	24.600
14-Feb-06	Bone Pile	1509	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	1.675	4.940	-22.019	22.590
16-Nov-05	Bone Pile	1339	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	1.785	4.080	-21.282	21.870
30-May-06	Bone Pile	1822	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.222	4.640	-22.090	25.450
16-Nov-05	Bone Pile	1342	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.225	5.320	-21.811	27.150
30-May-06	Bone Pile	1823	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.234	5.710	-21.824	26.360
14-Feb-06	Bone Pile	1508	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.416	5.060	-21.146	24.770
30-May-06	Bone Pile	1820	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.749	5.090	-21.827	25.020
14-Feb-06	Surprise Sink	1567	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.758	4.660	-20.648	20.570
16-Nov-05	Bone Pile	1341	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.883	5.020	-21.491	24.920
30-May-06	Bone Pile	1821	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.953	5.620	-21.307	25.580

16-Nov-05	Bone Pile	1340	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.966	4.240	-21.693	24.720
30-May-06	Bone Pile	1821	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	3.093	5.890	-21.764	27.600
16-Nov-05	Bone Pile	1344	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	3.196	4.490	-22.561	27.140
14-Feb-06	Bone Pile	1507	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	3.558	5.250	-22.117	27.320
14-Feb-06	Bone Pile	1506	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	3.683	7.230	-21.793	33.110
14-Feb-06	Bone Pile	1510	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	4.180	4.900	-23.035	29.250
16-Feb-06	Slaughter Creek	1585	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	1.297	3.990	-19.625	18.200
8-Nov-05	Lost Oasis	1280	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.450	5.775	-20.338	21.114
31-Aug-05	Slaughter Creek	1181	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.518	5.820	-20.766	28.500
26-Aug-05	La Crosse	1146	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.762	5.020	-18.789	20.800
8-Nov-05	Lost Oasis	1281	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.854	4.860	-20.390	20.817
16-Feb-06	Slaughter Creek	1586	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.895	4.870	-19.872	20.490
8-Nov-05	Lost Oasis	1282	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	3.154	3.910	-19.067	19.010
31-Aug-05	Slaughter Creek	1180	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	3.259	4.150	-19.895	23.550
8-Nov-05	Lost Oasis	1279	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	3.463	3.933	-22.544	21.611
24-May-06	Slaughter Creek	1745	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	3.927	3.380	-21.717	18.170
24-May-06	Slaughter Creek	1742	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	4.021	4.930	-20.430	23.620
8-Nov-05	Lost Oasis	1283	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	4.392	5.280	-19.662	
24-May-06	Slaughter Creek	1741	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	4.514	4.210	-20.630	24.270
26-Aug-05	La Crosse	1147	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	4.657	4.700	-19.374	20.762
24-May-06	Slaughter Creek	1743	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	4.794	4.040	-21.608	23.060
31-Aug-05	Slaughter Creek	1182	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	5.344	4.650	-19.930	27.620
28-Feb-06	Lost Oasis	1632	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	5.557	2.950	-19.911	16.860
31-Aug-05	Slaughter Creek	1183	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	7.203	4.900	-20.017	25.640
28-Feb-06	Lost Oasis	1629	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	7.271	4.770	-20.184	24.360
31-Aug-05	Slaughter Creek	1184	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	7.563	4.190	-16.885	22.450
16-Feb-06	Slaughter Creek	1584	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	7.792	4.420	-20.741	22.880
31-Aug-05	Slaughter Creek	1185	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	8.884	4.230	-18.000	20.820
28-Feb-06	Lost Oasis	1631	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism			-20.864	23.490
28-Feb-06	Lost Oasis	1630	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism			-20.830	22.610
24-May-06	Slaughter Creek	1744	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism			-21.322	26.530
25-May-06	Driskill	1783	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	2.586	4.430	-22.244	22.230
25-May-06	Academy	1772	Speodesmus sp.	Cave Milliped	Polydesmidae	Polydesmida	Organism	6.121	5.240	-21.242	25.290
23-Nov-05	La Crosse	1395	Pseudouroctonus reddelli	Scorpion	Vaejovidae	Scorpiones	Organism	6.665	11.720	-21.747	47.820
23-Nov-05	La Crosse	1396	Pseudouroctonus reddelli	Scorpion	Vaejovidae	Scorpiones	Organism	7.122	10.500	-21.685	47.610
23-Nov-05	La Crosse	1394	Pseudouroctonus reddelli	Scorpion	Vaejovidae	Scorpiones	Organism	9.448	11.460	-20.561	48.040
30-May-06	Surprise Sink	1851	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.133	3.030	-22.528	16.560
14-Feb-06	Surprise Sink	1533	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.189	2.500	-22.181	15.950
30-May-06	Surprise Sink	1848	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.195	3.080	-23.072	20.000
30-May-06	Bone Pile	1793	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.349	3.530	-24.665	32.420
14-Feb-06	Surprise Sink	1535	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.357	2.750	-22.588	18.170
14-Feb-06	Surprise Sink	1533	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.430	2.660	-22.139	16.980
14-Feb-06	Surprise Sink	1534	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.627	2.890	-23.160	26.250
30-May-06	Bone Pile	1790	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.660	3.270	-24.330	27.150
14-Feb-06	Bone Pile	1482	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.670	3.920	-21.968	25.820
14-Feb-06	Surprise Sink	1536	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.742	3.060	-23.276	21.710
16-Nov-05	Bone Pile	1336	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.759	3.620	-23.338	31.320
30-May-06	Surprise Sink	1851	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.788	3.200	-22.621	17.550
16-Nov-05	Bone Pile	1334	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.792	3.750	-23.138	24.020
30-May-06	Bone Pile	1792	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.862	3.880	-24.502	31.700
15-Nov-05	Surprise Sink	1294	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.945	3.350	-23.479	
15-Nov-05	Surprise Sink	1292	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.105	3.700	-23.399	
30-May-06	Surprise Sink	1849	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.125	3.540	-22.189	22.690
30-May-06	Bone Pile	1789	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.194	3.350	-24.690	29.390
30-May-06	Surprise Sink	1847	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.311	3.430	-22.642	20.690
30-May-06	Bone Pile	1791	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.404	3.470	-24.577	28.980
15-Nov-05	Surprise Sink	1293	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.561	3.070	-23.212	
16-Nov-05	Bone Pile	1333	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.579	3.920	-23.534	28.290
16-Nov-05	Bone Pile	1335	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.010	3.340	-23.691	28.420
16-Nov-05	Bone Pile	1335	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.011	3.830	-23.881	32.740

30-May-06	Surprise Sink	1850	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.074	3.780	-21.790	22.160
14-Feb-06	Bone Pile	1479	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.121	3.870	-23.628	31.700
14-Feb-06	Bone Pile	1480	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.765	3.800	-21.154	24.300
16-Nov-05	Bone Pile	1332	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.789	3.690	-22.987	25.760
14-Feb-06	Bone Pile	1481	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	6.073	4.060	-21.561	27.860
23-Aug-05	Bone Pile	1101	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism			-22.670	24.170
23-Aug-05	Bone Pile	1101	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism			-21.930	22.945
22-May-06	Lost Oasis	1652	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	2.845	4.040	-19.701	18.510
8-Nov-05	Lost Oasis	1269	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.125	3.155	-24.271	25.790
8-Nov-05	Lost Oasis	1270	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.525	3.669	-22.925	21.084
28-Feb-06	Lost Oasis	1611	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.564	3.470	-23.066	21.400
8-Nov-05	Lost Oasis	1268	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.677	3.783	-23.681	26.296
8-Nov-05	Lost Oasis	1271	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.741	3.679	-23.831	23.719
26-Aug-05	La Crosse	1121	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.940	3.324	-20.450	20.806
22-May-06	Lost Oasis	1650	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.030	2.990	-23.187	22.110
26-Aug-05	La Crosse	1120	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.230	4.099	-21.900	30.084
28-Feb-06	Lost Oasis	1615	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.312	4.320	-22.626	25.940
26-Aug-05	La Crosse	1122	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.320	3.184	-21.360	28.639
8-Nov-05	Lost Oasis	1267	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.388	4.010	-24.509	28.341
28-Feb-06	Lost Oasis	1614	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.511	3.610	-22.145	22.430
31-Aug-05	Slaughter Creek	1159	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.552	3.840	-24.193	29.490
22-May-06	Lost Oasis	1651	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.585	3.680	-22.951	24.760
31-Aug-05	Slaughter Creek	1160	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.622	4.210	-23.494	29.820
28-Feb-06	Lost Oasis	1613	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.705	3.520	-21.836	22.250
28-Feb-06	Lost Oasis	1612	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.727	3.130	-23.466	24.420
31-Aug-05	Slaughter Creek	1158	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.051	2.970	-22.954	21.810
31-Aug-05	Slaughter Creek	1161	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.150	3.660	-24.497	31.850
22-May-06	Lost Oasis	1653	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.155	3.540	-22.096	24.540
26-Aug-05	La Crosse	1123	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.790	4.010	-22.140	27.577
26-Aug-05	La Crosse	1124	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	6.060	3.335	-19.270	23.865
16-Feb-06	Slaughter Creek	1574	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	6.988	3.110	-23.461	24.450
21-Nov-05	Genesis	1355	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	2.870	3.120	-22.368	21.290
23-Aug-05	Genesis	1077	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.160	3.471	-22.860	26.089
14-Feb-06	Genesis	1521	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.181	2.440	-20.806	17.800
21-Nov-05	Genesis	1353	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	3.943	2.620	-20.571	18.380
21-Nov-05	Genesis	1353	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.025	2.820	-20.694	18.840
30-May-06	Genesis	1835	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.146	2.760	-23.944	27.100
23-Aug-05	Genesis	1079	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.330	3.721	-23.470	25.805
30-May-06	Genesis	1830	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.366	2.890	-22.066	19.600
14-Feb-06	Genesis	1520	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.536	2.910	-22.690	19.680
23-Aug-05	Genesis	1081	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.560	3.526	-23.320	27.663
21-Nov-05	Genesis	1356	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.569	3.620	-24.269	22.250
14-Feb-06	Genesis	1522	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.582	2.640	-21.835	20.090
30-May-06	Genesis	1832	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	4.719	2.750	-20.547	17.900
30-May-06	Genesis	1833	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.068	3.240	-21.899	26.860
14-Feb-06	Genesis	1519	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.152	2.670	-22.414	17.600
23-Aug-05	Genesis	1078	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.210	3.668	-21.680	22.458
23-Aug-05	Genesis	1080	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.350	4.095	-21.830	24.886
14-Feb-06	Genesis	1518	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.556	2.560	-21.488	17.080
30-May-06	Genesis	1831	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	5.685	2.660	-20.795	19.720
30-May-06	Genesis	1831	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	6.005	2.860	-21.086	20.930
21-Nov-05	Genesis	1354	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	6.067	3.010	-19.603	21.150
21-Nov-05	Genesis	1357	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	6.507	3.030	-23.733	28.160
29-Nov-05	Driskill	1405	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	6.806	3.900	-22.496	24.420
29-Nov-05	Driskill	1408	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	7.230	4.410	-22.891	27.190
29-Nov-05	Driskill	1406	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism	7.546	3.130	-22.925	21.610
29-Nov-05	Driskill	1407	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism			-22.316	17.760
29-Nov-05	Driskill	1407	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism			-21.862	17.190
14-Feb-06	Genesis	1518	Cambala sp.	Cave Milliped	Cambalidae	Spirostreptida	Organism			-21.305	15.330
28-Jul-05	Surprise Sink	1009	unidentified Diplopoda	Milliped	unidentified	unidentified	Organism	3.350	3.170	-24.220	29.300

					Diplopoda	Diplopoda					
28-Jul-05	Surprise Sink	1008	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	3.350	3.490	-23.240	28.040
28-Jul-05	Surprise Sink	1005	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	4.060	3.580	-23.940	26.830
28-Jul-05	Surprise Sink	1007	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	4.060	3.940	-23.820	32.730
28-Jul-05	Surprise Sink	1006	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	4.390	3.910	-23.490	29.200
17-Aug-05	Lost Oasis	1062	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	1.510	5.322	-17.910	20.201
17-Aug-05	Lost Oasis	1063	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	2.150	6.087	-21.370	25.013
17-Aug-05	Lost Oasis	1060	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	2.340	5.734	-19.660	22.273
17-Aug-05	Lost Oasis	1064	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	2.520	5.378	-20.025	22.889
17-Aug-05	Lost Oasis	1044	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	2.800	4.410	-22.570	22.660
17-Aug-05	Lost Oasis	1041	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	2.940	4.290	-23.600	26.890
17-Aug-05	Lost Oasis	1061	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism	5.140	5.083	-19.600	22.858
17-Aug-05	Lost Oasis	1042	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism			-24.630	27.740
17-Aug-05	Lost Oasis	1040	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism			-23.680	25.300
17-Aug-05	Lost Oasis	1043	unidentified Diplopoda	Milliped	unidentified Diplopoda	unidentified Diplopoda	Organism			-23.610	26.230
30-May-06	Bone Pile	1824	Texoreddellia sp.	Bristletail	Nicoletiidae	Zygentoma	Organism	4.526	8.970	-22.876	44.000
23-Aug-05	Bone Pile	1096	Eupatorium ?	Boneset ?	Asteraceae ?	Asterale	Leaves	-1.034	2.284	-32.150	44.082
15-May-06	Blowing Sink	1924	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	-0.409	1.273	-12.964	35.936
31-Aug-05	Blowing Sink	1201	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	-0.150	1.458	-13.581	37.980
15-Nov-05	Surprise Sink	1321	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	0.612	0.614	-10.702	30.930
30-May-06	Bone Pile	1786	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	1.868	1.725	-14.501	38.030
6-Nov-05	Blowing Sink	1266	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	2.348	0.863	-12.487	37.259
30-May-06	Surprise Sink	1844	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	2.427	0.876	-9.979	35.330
14-Feb-06	Surprise Sink	1572	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	3.713	0.623	-12.305	37.350
14-Feb-06	Bone Pile	1514	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	4.833	0.963	-11.857	38.640
2-Feb-06	Blowing Sink	1477	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes			-13.444	37.460
16-Nov-05	Bone Pile	1346	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes			-12.247	37.760
28-Jul-05	Surprise Sink	1003	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladode			-12.670	34.980
28-Feb-06	Lost Oasis	1637	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	-0.941	0.690	-12.195	36.850
22-May-06	Lost Oasis	1647	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	-0.477		-12.352	36.610
8-Nov-05	Lost Oasis	1289	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	0.330	0.548	-12.941	
16-Feb-06	Slaughter Creek	1590	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	0.361	1.045	-11.976	31.605
23-Feb-06	La Crosse	1603	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	1.878	0.706	-12.889	36.310
24-May-06	La Crosse	1679	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes			-12.445	43.270

23-Nov-05	La Crosse	1403	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes			-11.283	39.940
17-Aug-05	Lost Oasis	1038	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes			-13.290	35.620
29-Nov-05	Slaughter Creek	1424	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes			-12.357	34.870
24-May-06	Slaughter Creek	1708	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes			-11.050	41.290
30-May-06	Genesis	1827	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	1.900	0.744	-11.320	36.120
23-Aug-05	Genesis	1074	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes & Fruit	2.365	0.926	-12.555	38.337
25-May-06	Driskill	1777	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Leaves	2.993	0.662	-11.057	35.600
23-Feb-06	Driskill	1596	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	3.341		-11.274	30.430
14-Feb-06	Genesis	1529	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	3.472	1.125	-12.949	37.135
31-Aug-05	Driskill	1226	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	3.944	1.523	-11.461	32.540
29-Nov-05	Driskill	1413	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes	5.139	1.349	-10.926	29.140
21-Nov-05	Genesis	1369	Opuntia cf. phaecantha Engelm.	Engelmann's Prickly-Pear	Cactaceae	Caryophyllales	Cladodes & fruit			-12.293	36.460
29-Nov-05	Driskill	1414	Ilex decidua Walter	Possumhaw	Aquifoliaceae	Celastrales	Leaves	0.685	0.951	-29.235	45.720
2-Feb-06	Blowing Sink	1478	Ilex vomitoria Sol.	Yaupon	Aquifoliaceae	Celastrales	Leaves	-0.360	2.399	-30.713	48.130
16-Feb-06	Slaughter Creek	1588	Ilex vomitoria Sol.	Yaupon	Aquifoliaceae	Celastrales	Leaves	-0.715	1.542	-30.058	46.852
24-May-06	Slaughter Creek	1711	Ilex vomitoria Sol.	Yaupon	Aquifoliaceae	Celastrales	Leaves	-0.241	1.557	-27.948	55.915
29-Nov-05	Slaughter Creek	1425	Ilex vomitoria Sol.	Yaupon	Aquifoliaceae	Celastrales	Leaves			-29.470	49.160
14-Feb-06	Bone Pile	1511	Garrya ovata Benth. subsp. lindheimeri (Torr.) Dahling	Lindheimer's Silktassel	Garryaceae	Cornales	Leaves	1.130	1.303	-28.846	48.480
14-Feb-06	Surprise Sink	1570	Carex planostachys Kuntze	Cedar sedge	Cyperaceae	Cyperales	Leaves	2.233	1.258	-29.853	45.670
15-Nov-05	Surprise Sink	1318	Carex planostachys Kuntze	Cedar sedge	Cyperaceae	Cyperales	Leaves			-27.082	
31-Aug-05	Slaughter Creek	1155	Carex planostachys Kuntze	Cedar sedge	Cyperaceae	Cyperales	Leaves	0.409	1.244	-28.030	45.830
16-Feb-06	Slaughter Creek	1589	Carex planostachys Kuntze	Cedar sedge	Cyperaceae	Cyperales	Leaves	0.436	1.311	-31.737	40.650
23-Feb-06	La Crosse	1602	Carex planostachys Kuntze	Cedar sedge	Cyperaceae	Cyperales	Leaves	2.224		-31.754	40.200
14-Feb-06	Genesis	1528	Carex planostachys Kuntze	Cedar sedge	Cyperaceae	Cyperales	Leaves			-29.283	43.550
24-May-06	La Crosse	1677	Bouteloua rigidiseta (Steud.) A.S. Hitchc.	Texas Grama	Poaceae	Cyperales	Leaves			-29.099	44.900
25-May-06	Academy	1754	Bromus catharticus Vahl	Rescue Grass	Poaceae	Cyperales	Leaves	2.741	1.995	-29.167	42.750
6-Nov-05	Blowing Sink	1264	Nassella leucotricha (Trin. & Rupr.) Barkworth	Texas Winter Grass	Poaceae	Cyperales	Leaves	0.284	0.980	-27.586	41.325
31-Aug-05	Blowing Sink	1199	Nassella leucotricha (Trin. & Rupr.) Barkworth	Texas Winter Grass	Poaceae	Cyperales	Leaves	1.226	1.206	-31.197	42.640
2-Feb-06	Blowing Sink	1475	Nassella leucotricha (Trin. & Rupr.) Barkworth	Texas Winter Grass	Poaceae	Cyperales	Leaves			-28.912	42.100
23-Nov-05	La Crosse	1401	Nassella leucotricha (Trin. & Rupr.) Barkworth	Texas Winter Grass	Poaceae	Cyperales	Leaves			-30.866	42.080
28-Feb-06	Lost Oasis	1635	Nassella leucotricha (Trin. & Rupr.) Barkworth	Texas Winter Grass	Poaceae	Cyperales	Leaves			-29.186	43.800
29-Nov-05	Driskill	1411	Panicum cf. aciculare Desv. ex Poir.	Needleleaf Rosette Grass	Poaceae	Cyperales	Leaves			-28.289	43.720
14-Feb-06	Bone Pile	1512	unidentified Poaceae	Unknown grass	Poaceae	Cyperales	Leaves	0.635	1.629	-27.028	44.240
24-May-06	Slaughter Creek	1709	Bothriochloa ischaemum (L.) Keng var. songarica (Rupr. ex Fisch. & C.A. Mey.) Celarier & Harlan	King Ranch Bluestem	Poaceae	Cyperales	Leaves			-11.972	46.900

21-Nov-05	Genesis	1367	cf. Bothriochloa ischaemum (L.) Keng	King Ranch Bluestem	Poaceae	Cyperales	Leaves			-12.554	39.740
25-May-06	Driskill	1774	Bouteloua curtipendula (Michx.) Torr.	Side-oats Grama	Poaceae	Cyperales	Leaves	1.071	1.656	-14.454	42.440
28-Jul-05	Surprise Sink	1002	cf. Eragrostis	Love Grass?	Poaceae	Cyperales	Grass Blades	-0.651	1.215	-12.640	39.060
26-Aug-05	La Crosse	1150	cf. Eragrostis	Love Grass?	Poaceae	Cyperales	Leaves	2.166	1.608	-13.033	44.800
23-Feb-06	Driskill	1593	cf. Eragrostis	Love Grass?	Poaceae	Cyperales	Leaves	2.894		-12.736	40.950
23-Aug-05	Genesis	1071	cf. Eragrostis	Love Grass?	Poaceae	Cyperales	Leaves	3.036	1.558	-14.350	41.905
30-Nov-05	Academy	1431	Cynodon dactylon (L.) Pers.	Bermuda Grass	Poaceae	Cyperales	Leaves			-14.890	42.520
8-Nov-05	Lost Oasis	1285	Buchloe dactyloides (Nutt.) Engelm.	Buffalo Grass	Poaceae	Cyperales	Leaves	-0.317	1.155	-14.331	
16-Nov-05	Bone Pile	1345	Eragrostis intermedia Hitchc.	Plains Love Grass	Poaceae	Cyperales	Leaves	0.326	1.375	-14.031	43.250
30-May-06	Bone Pile	1785	unidentified, grass-like C3 plant	unidentified, grass-like C3 plant	unidentified, grass-like C3 plant	Cyperales	Leaves	1.794	2.805	-30.236	44.320
30-May-06	Surprise Sink	1843	unidentified, grass-like C3 plant	unidentified, grass-like C3 plant	unidentified, grass-like C3 plant	Cyperales	Leaves	2.143	1.414	-27.624	37.460
31-Aug-05	Driskill	1224	unidentified, grass-like C3 plant	unidentified, grass-like C3 plant	unidentified, grass-like C3 plant	Cyperales	Leaves	-0.946	0.786	-31.908	37.075
31-Aug-05	Driskill	1225	unidentified, grass-like C3 plant	unidentified, grass-like C3 plant	unidentified, grass-like C3 plant	Cyperales	Leaves	0.112	1.310	-31.970	37.580
30-May-06	Genesis	1825	unidentified, grass-like C4 plant	unidentified, grass-like C4 plant	unidentified, grass-like C4 plant	Cyperales	Leaves	0.962	1.539	-13.612	43.100
30-May-06	Surprise Sink	1845	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	-0.347	1.915	-28.177	44.850
15-Nov-05	Bone Pile	1323	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	-0.069	1.536	-28.857	46.330
15-Nov-05	Surprise Sink	1320	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	0.061	1.516	-28.950	46.550
14-Feb-06	Surprise Sink	1573	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	0.499	1.377	-27.937	48.770
2-Feb-06	Blowing Sink	1476	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves			-29.375	40.960
2-Feb-06	Blowing Sink	1476	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves			-29.014	41.070
31-Aug-05	Slaughter Creek	1156	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	-0.896	1.648	-28.644	48.155
23-Feb-06	La Crosse	1605	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	-0.246	1.416	-30.003	45.190
24-May-06	Slaughter Creek	1710	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	0.289	1.796	-27.727	50.230
8-Nov-05	Lost Oasis	1288	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	0.731	1.369	-29.474	
22-May-06	Lost Oasis	1649	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	1.348		-29.135	49.620
26-Aug-05	La Crosse	1152	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	1.420	1.763	-30.241	47.320
23-Nov-05	La Crosse	1404	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves			-29.392	46.500
24-May-06	La Crosse	1680	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves			-28.700	47.320
16-Feb-06	Slaughter Creek	1591	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves			-30.013	44.140
21-Nov-05	Genesis	1370	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	0.269	1.440	-27.669	44.800
23-Aug-05	Genesis	1073	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	0.453	1.999	-27.810	46.037
14-Feb-06	Genesis	1531	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	0.587	1.558	-27.466	48.760
30-May-06	Genesis	1829	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	0.950	2.266	-27.165	45.260
23-Feb-06	Driskill	1597	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	2.747		-28.377	45.190

25-May-06	Academy	1756	Diospyros texana Scheele	Texas Persimmon	Ebenaceae	Ebenales	Leaves	2.857	2.294	-25.532	43.090
30-May-06	Bone Pile	1788	Cercis canadensis L. var. texensis (S. Wats.) M. Hopkins	Texas Redbud	Fabaceae	Fabales	Leaves	0.420	1.657	-28.946	47.010
23-Aug-05	Bone Pile	1098	Cercis canadensis L. var. texensis (S. Wats.) M. Hopkins	Texas Redbud	Fabaceae	Fabales	Leaves	1.217	1.747	-31.880	46.410
15-Nov-05	Bone Pile	1324	Cercis canadensis L. var. texensis (S. Wats.) M. Hopkins	Texas Redbud	Fabaceae	Fabales	Leaves			-30.689	45.010
14-Feb-06	Surprise Sink	1571	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	-0.885	1.393	-27.466	50.465
28-Jul-05	Surprise Sink	1000	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	0.190	2.184	-27.490	43.880
29-Nov-05	Slaughter Creek	1423	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	-0.440	1.982	-29.149	49.100
22-May-06	Lost Oasis	1648	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	0.220		-27.930	48.070
8-Nov-05	Lost Oasis	1287	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	0.227	1.431	-29.010	
23-Feb-06	La Crosse	1604	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	0.278	1.248	-28.753	44.860
28-Feb-06	Lost Oasis	1638	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	0.304	1.610	-29.209	48.670
23-Nov-05	La Crosse	1402	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves			-30.939	47.920
17-Aug-05	Lost Oasis	1037	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves			-29.550	46.000
14-Feb-06	Genesis	1530	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	0.330	1.087	-28.033	48.100
23-Feb-06	Driskill	1595	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	1.588		-27.651	46.000
30-May-06	Genesis	1828	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves	1.608	1.352	-24.110	48.340
21-Nov-05	Genesis	1368	Quercus fusiformis Small	Plateau Live Oak	Fagaceae	Fagales	Leaves			-27.099	45.880
30-May-06	Bone Pile	1787	Quercus shumardii Buckley	Shumard's Oak	Fagaceae	Fagales	Leaves	0.467	1.967	-28.307	47.770
23-Aug-05	Bone Pile	1099	Quercus shumardii Buckley	Shumard's Oak	Fagaceae	Fagales	Leaves	1.632	1.607	-30.230	48.973
15-Nov-05	Bone Pile	1325	Quercus shumardii Buckley	Shumard's Oak	Fagaceae	Fagales	Leaves			-30.034	48.030
23-Aug-05	Bone Pile	1095	Smilax bona-nox L.	Saw Greenbrier	Smilacaceae	Liliales	Leaves	1.311	1.971	-30.730	46.183
26-Aug-05	La Crosse	1151	Smilax bona-nox L.	Saw Greenbrier	Smilacaceae	Liliales	Leaves	1.512	1.729	-26.891	48.350
17-Aug-05	Lost Oasis	1039	Smilax bona-nox L.	Saw Greenbrier	Smilacaceae	Liliales	Leaves			-33.400	45.970
28-Jul-05	Surprise Sink	1001	Juniperus ashei J. Buchholz	Ashe's juniper	Cupressaceae	Pinales	Leaves	-0.651	1.215	-26.860	41.870
15-Nov-05	Surprise Sink	1317	Juniperus ashei J. Buchholz	Ashe's juniper	Cupressaceae	Pinales	Leaves	-0.436	0.963	-25.968	
14-Feb-06	Bone Pile	1513	Juniperus ashei J. Buchholz	Ashe's juniper	Cupressaceae	Pinales	Leaves	-0.062	0.997	-27.597	48.990
2-Feb-06	Blowing Sink	1474	Juniperus ashei J. Buchholz	Ashe's juniper	Cupressaceae	Pinales	Leaves			-26.807	46.630
31-Aug-05	Slaughter Creek	1153	Juniperus ashei J. Buchholz	Ashe's juniper	Cupressaceae	Pinales	Leaves	0.113	0.982	-28.657	50.300
31-Aug-05	Driskill	1221	Juniperus ashei J. Buchholz	Ashe's juniper	Cupressaceae	Pinales	Leaves	-0.119	1.151	-29.267	34.800
29-Nov-05	Driskill	1410	Juniperus ashei J. Buchholz	Ashe's juniper	Cupressaceae	Pinales	Leaves			-26.516	48.900
14-Feb-06	Surprise Sink	1569	Berberis trifoliolata Moric.	Algarita	Berberidaceae	Ranunculales	Leaves	-0.558	1.244	-26.703	50.830
23-Feb-06	La Crosse	1601	Berberis trifoliolata Moric.	Algarita	Berberidaceae	Ranunculales	Leaves	-0.040		-29.619	48.120
16-Feb-06	Slaughter Creek	1587	Berberis trifoliolata Moric.	Algarita	Berberidaceae	Ranunculales	Leaves	0.231	1.683	-30.463	43.610
26-Aug-05	La Crosse	1148	Berberis trifoliolata Moric.	Algarita	Berberidaceae	Ranunculales	Leaves	0.831	1.654	-28.821	49.330
28-Feb-06	Lost Oasis	1634	Berberis trifoliolata Moric.	Algarita	Berberidaceae	Ranunculales	Leaves	1.903	1.652	-27.390	41.400
14-Feb-06	Genesis	1527	Berberis trifoliolata Moric.	Algarita	Berberidaceae	Ranunculales	Leaves	-0.629	1.610	-26.859	48.470
28-Feb-06	Academy	1607	Berberis trifoliolata Moric.	Algarita	Berberidaceae	Ranunculales	Leaves	3.899	1.747	-27.290	46.360
30-May-06	Bone Pile	1784	Prunus sp	Cherry	Rosaceae	Rosales	Leaves		1.605	-26.788	49.335
23-Aug-05	Bone Pile	1097	Ungnadia speciosa Endl.	Mexican-Buckeye	Sapindaceae	Sapindales	Leaves	0.606	2.006	-29.030	47.018
28-Jul-05	Surprise Sink	1004	Forestiera pubescens Nutt. var. pubescens	Spring-Herald, Elbow-Bush, Stretchberry	Oleaceae	Scrophulariales	Leaves	-0.500	1.315	-24.840	46.105
30-May-06	Surprise Sink	1842	Forestiera pubescens Nutt. var. pubescens	Spring-Herald, Elbow-Bush, Stretchberry	Oleaceae	Scrophulariales	Leaves	-0.370	1.895	-27.451	44.710
15-May-06	Blowing Sink	1925	Forestiera pubescens Nutt. var. pubescens	Spring-Herald, Elbow-Bush, Stretchberry	Oleaceae	Scrophulariales	Leaves	0.594	2.139	-30.470	41.782
6-Nov-05	Blowing Sink	1263	Forestiera pubescens	Spring-Herald, Elbow-	Oleaceae	Scrophulariales	Leaves	1.937	1.315	-30.801	41.408

			Nutt. var. pubescens	Bush, Stretchberry							
31-Aug-05	Blowing Sink	1198	Forestiera pubescens Nutt. var. pubescens	Spring-Herald, Elbow-Bush, Stretchberry	Oleaceae	Scrophulariales	Leaves	2.544	1.758	-28.985	49.440
31-Aug-05	Driskill	1223	Forestiera pubescens Nutt. var. pubescens	Spring-Herald, Elbow-Bush, Stretchberry	Oleaceae	Scrophulariales	Leaves	0.017	1.796	-27.702	47.440
25-May-06	Driskill	1776	Ligustrum japonicum Thunb.	Japanese Privet	Oleaceae	Scrophulariales	Leaves	0.129	2.124	-27.612	47.700
23-Feb-06	Driskill	1594	Ligustrum japonicum Thunb.	Japanese Privet	Oleaceae	Scrophulariales	Leaves	0.163		-28.735	41.820
26-Aug-05	Academy	1189	Ligustrum japonicum Thunb.	Japanese Privet	Oleaceae	Scrophulariales	Leaves	3.001	2.070	-29.401	42.950
28-Feb-06	Academy	1608	Ligustrum japonicum Thunb.	Japanese Privet	Oleaceae	Scrophulariales	Leaves	4.157	2.442	-27.383	41.635
29-Nov-05	Driskill	1412	Ligustrum japonicum Thunb.	Japanese Privet	Oleaceae	Scrophulariales	Leaves			-27.445	45.570
25-May-06	Academy	1753	Capsicum annuum L. var. glabriusculum (Dunal) Heiser & Pickersgill	Chilitepin, Chile Piquin, Bird Pepper	Solanaceae	Solanales	Leaves	3.948	5.278	-26.641	43.950
26-Aug-05	Academy	1186	Capsicum annuum L. var. glabriusculum (Dunal) Heiser & Pickersgill	Chilitepin, Chile Piquin, Bird Pepper	Solanaceae	Solanales	Leaves	4.325	2.708	-27.183	49.275
30-Nov-05	Academy	1430	Capsicum annuum L. var. glabriusculum (Dunal) Heiser & Pickersgill	Chilitepin, Chile Piquin, Bird Pepper	Solanaceae	Solanales	Leaves			-28.246	42.360
15-Nov-05	Surprise Sink	1319	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves	-0.967	0.905	-27.927	
31-Aug-05	Blowing Sink	1200	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves	-0.337	2.197	-28.378	40.320
6-Nov-05	Blowing Sink	1265	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves	0.360	1.434	-28.632	38.441
15-May-06	Blowing Sink	1922	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves	0.477	2.423	-29.242	37.081
22-May-06	Lost Oasis	1646	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves	0.251	2.200	-31.010	40.140
8-Nov-05	Lost Oasis	1286	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves	3.108	1.135	-26.110	
17-Aug-05	Lost Oasis	1036	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves			-27.050	36.440
23-Aug-05	Genesis	1072	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves	-0.640	1.565	-26.440	45.097
30-May-06	Genesis	1826	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves	1.278	2.043	-25.044	44.600
25-May-06	Driskill	1775	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves	1.450	1.964	-26.645	42.180
21-Nov-05	Genesis	1366	Celtis laevigata Willd. var. reticulata (Torr.) L. Benson	Netleaf Hackberry	Ulmaceae	Urticales	Leaves			-26.751	42.770
24-May-06	La Crosse	1678	Celtis laevigata Willd. var. texana (Scheele) Sarg.	Texas Sugarberry	Ulmaceae	Urticales	Leaves			-29.897	40.830
25-May-06	Academy	1755	Celtis laevigata Willd. var. texana (Scheele) Sarg.	Texas Sugarberry	Ulmaceae	Urticales	Leaves	2.886	2.018	-27.767	41.740
30-Nov-05	Academy	1432	Celtis laevigata Willd. var. texana (Scheele) Sarg.	Texas Sugarberry	Ulmaceae	Urticales	Leaves			-28.740	36.750
15-May-06	Blowing Sink	1923	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	-0.187	2.595	-28.225	38.024
6-Nov-05	Blowing Sink	1262	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	0.292	1.616	-26.527	43.209

31-Aug-05	Blowing Sink	1197	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	0.350	2.372	-28.585	45.660
30-May-06	Surprise Sink	1841	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	0.547	2.187	-27.151	43.350
29-Nov-05	Slaughter Creek	1421	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	-1.315	0.935	-29.448	39.720
31-Aug-05	Slaughter Creek	1154	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	0.339	1.545	-27.799	47.280
26-Aug-05	La Crosse	1149	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	0.905	1.686	-30.205	45.770
23-Nov-05	La Crosse	1400	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves			-30.476	45.500
22-May-06	La Crosse	1676	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves			-29.732	44.940
24-May-06	Slaughter Creek	1707	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves			-26.312	48.100
31-Aug-05	Driskill	1222	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	0.551	1.594	-28.228	42.740
25-May-06	Driskill	1773	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	0.696	1.772	-28.542	42.600
25-May-06	Academy	1752	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves	4.567	1.790	-26.699	47.070
30-Nov-05	Academy	1429	Ulmus crassifolia Nutt.	Cedar Elm	Ulmaceae	Urticales	Leaves			-28.719	42.300

Administrative Record Excerpt 5

R004780 - R004784

Final Rule To Determine Five Texas Cave Invertebrates
To Be Endangered Species

DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

Endangered and Threatened Wildlife and Plants; Final Rule To Determine Five Texas Cave Invertebrates To Be Endangered Species

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: The Service determines endangered status under the authority of the Endangered Species Act of 1973, as amended, for five species of cave-dwelling, invertebrate animals in Texas. The five species are the Tooth Cave pseudoscorpion (*Microcreagris texana*), the Tooth Cave spider (*Leptoneta myopica*), the Bee Creek Cave harvestman (*Texella reddelli*), the Tooth Cave ground beetle (*Rhadine persephone*), and the Kretschmarr Cave mold beetle (*Texamaurops reddelli*). Each of these species is known from only six or fewer small, shallow, dry caves near Austin in Travis and Williamson Counties, Texas. Urban, industrial, and highway expansion are planned or ongoing in the area containing the cave habitat of these species. This development could result in filling or collapse of these shallow caves, disturbances of water drainage patterns that affect cave habitat, introduction of exotic competitive and predatory insects and other organisms,

and pollution of the cave systems with pesticides, fertilizers, oils, and other harmful substances. Final determination that these five species are endangered implements for them the protections provided by the Endangered Species Act.

EFFECTIVE DATE: September 16, 1988.

ADDRESSES: The complete file for this rule is available for inspection, by appointment, during normal business hours at the Service's Regional Office of Endangered Species, 500 Gold Avenue SW., Albuquerque, New Mexico 87103.

FOR FURTHER INFORMATION CONTACT: Dr. Steven M. Chambers, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service Regional Office, Albuquerque, New Mexico (See ADDRESSES above) (505/766–3972 or FTS 474–3972).

SUPPLEMENTARY INFORMATION:

Effective Date

The usual 30-day delay between date of publication of a final rule and its effective date may be waived for cause, as provided by 50 CFR 424.18(b)(1) and by the Administrative Procedure Act (5 U.S.C. 553(d)(3)). The Service finds that this period be waived for this rule because immediate protection is needed to meet the ongoing threat of construction activities that are taking place on land that includes all or a major portion of each of the subject species' habitat.

Background

The Tooth Cave pseudoscorpion, *Microcreagris texana* (family Neobisiidae), was first described by Muchmore (1969) from a specimen collected in Tooth Cave, Travis County, by James Reddell in 1965. It reaches a length of about 4 millimeters (mm) (about 3/16 inch) and resembles a tiny, tailless scorpion. Pseudoscorpions lack a stinger and are harmless to humans. They use their pincers to prey on small insects and other arthropods. The Tooth Cave pseudoscorpion is eyeless and troglobitic (lives only in caves). It is known only from Tooth and Amber Caves, both in Travis County, Texas.

The Tooth Cave spider, *Leptoneta myopica* (family Leptonetidae), was first collected by James Reddell in 1963, and later described by Gertsch (1974). It has been found only in Tooth Cave, Travis County, Texas. This spider is very small, up to 1.6 mm (about 1/16 inch) in total length, pale colored, and has relatively long legs. It is a troglobite, although reduced eyes are present. The Tooth Cave spider is sedentary and spins webs from the ceiling and walls of Tooth Cave.

The Bee Creek Cave harvestman, *Texella reddelli* (family Phalangodidae), was first described by Goodnight and Goodnight (1967) from a specimen collected by James Reddell and David McKenzie from Bee Creek Cave (erroneously reported as "Pine Creek Cave"), Travis County. This light yellowish-brown harvestman has relatively long legs that extend from a small body (2 mm, or less than 1/8 inch, in length). It is an eyeless troglobite and is probably predatory. The Bee Creek Cave harvestman lives in Tooth, Bee Creek, McDonald, Weldon, and Bone Caves in Travis and Williamson Counties, Texas. The *Texella* reported by Reddell (1984) from Root Cave, Travis County, may also be this species.

The Tooth Cave ground beetle, *Rhadine persephone* (family Carabidae), was first described by Barr (1974) from specimens collected in the Tooth Cave by W.M. Andrews, R.W. Mitchell, and T.C. Barr in 1965. This species is a small (7–8 mm or about 5/16 inch in length), reddish-brown beetle. It is troglobitic and has only rudimentary eyes. It probably feeds on cave cricket eggs, which have been determined to be a major food of another troglobite species of *Rhadine* (Mitchell 1968). The Tooth Cave ground beetle is known only from Tooth and Kretschmarr Caves, Travis County, Texas.

The Kretschmarr Cave mold beetle, *Texamaurops reddelli*, was first described by Barr and Steeves (1963) from a specimen collected in Kretschmarr Cave by James R. Reddell and David McKenzie in 1963. This species is a very small (less than 3 mm, or about 1/8 inch, in length) dark-colored, short-winged, beetle with elongated legs. This member of the family Pselaphidae is an eyeless troglobite and is known only from Kretschmarr, Amber, Tooth, and Coffin Caves in Travis and Williamson Counties, Texas.

The caves inhabited by these five species are relatively small. The largest, McDonald Cave, consists of less than 60 meters (m) (about 200 feet) of passage, and most of the others are considerably smaller. These caves occur in isolated "islands" of the Edwards Limestone formation that were separated from one another when stream channels cut through the overlying limestone to lower rock layers. This fragmentation of habitat has resulted in the isolation of groups of caves that have developed their own, highly localized faunas.

In addition to the five species that are the subject of this final rule, these caves and others in the area support a number of other uncommon and scientifically significant species. Available habitat of this type is very limited, and many of these caves have been lost or are threatened with imminent loss.

The Service was first notified of the possible status of these five species by an August 20, 1984, letter from the Travis Audubon Society, Austin, Texas. The Conservation Committee of the Travis Audubon Society then petitioned the Service on February 8, 1985, to list these five and one other species (the Tooth Cave rove beetle, *Cylindropsis* sp.) as endangered. The Service evaluated this petition and on May 1, 1985, found that the petition did present substantial information indicating that the requested action may be warranted. A notice of that finding was published in the **Federal Register** on July 18, 1985 (50 FR 29238). On February 19, 1986, the Service found that the petitioned action was warranted but that such action was precluded by work on other pending proposals, in accordance with section 4(b)(3)(iii) of the Act. A notice of that finding was published on August 20, 1986 (51 FR 29672). On July 1, 1987 (52 FR 24487), the Service published a notice that the petitioned action was again warranted but precluded for the five species addressed in the present final rule. That same notice also announced the finding that listing was not warranted for the sixth species named in the petition, the Tooth Cave blind rove beetle (*Cylindropsis* sp.). This conclusion was based on the determination that the single known specimen was in such poor condition that it could not provide adequate material for taxonomic evaluation and description; furthermore, the best available scientific information indicates that the taxon it represents is extinct. Endangered status for these five species was proposed on April 19, 1988 (53 FR 12787).

Summary of Comments and Recommendations

In the April 19, 1988, proposed rule (53 FR 12787) and associated notifications, all interested parties were requested to submit factual reports or information that might contribute to the development of a final rule. Appropriate State agencies, county governments, Federal agencies, scientific organizations, and other interested parties were contacted and requested to comment. A newspaper notice was published in the *American Statesman* (Austin, Texas) on May 25, 1988, which invited general public comment. Nine comments were received and are discussed below. The proposal is supported by the City of Austin, three organizations, and four individuals. A letter from the U.S. Department of Housing and Urban

Development contained no substantive comments on the proposed listings. No public hearing was requested or held.

Four commenters urged that the Service prepare an emergency listing for the five Texas cave invertebrates. The Service's expedited preparation and review of this final rule is in lieu of an emergency listing.

The City of Austin, three organizations, and three individuals requested that critical habitat be designated for these five species. The Services's reasons for not designating critical habitat are explained in the Critical Habitat section of this rule. Designation of critical habitat would not be prudent at this time because any benefits from that designation would be outweighed by the increase in unauthorized visitation and vandalism of the caves that would result from publication of precise critical habitat descriptions and maps. Although the Service agrees with one commenter that listing itself draws attention, to some extent, to the localities of these species, publication of maps and descriptions in local newspapers, which is required when designating critical habitat, would disseminate exact locality information to a much larger segment of the public. The Service notes that, even without critical habitat designation, the habitats of these species receive protection under section 7 of the Act.

Eight commenters provided information on development activities in the area, such as deep trenching, road and utility construction, and cave destruction. They expressed concern about these serious threats to the five species. The Service recognizes the potential negative impacts of these activities and the present listings are in response to them. Both direct effects, such as those mentioned above, and indirect effects, such as alteration of drainage patterns, have been considered.

Three commenters discussed the threat of fire ants and their effect on native cave fauna. The Service recognized the threat of exotic insects in the original proposal (Factor C).

One commenter urged emergency buying of an easement or actual purchase of the cave areas. These options will be considered by the Service in development of a recovery plan for these species.

Two commenters expressed support for placing grates over cave entrances, but expressed concern that grates be properly designed. The Service agrees that grates are needed and that their design must take into account the biological needs of the species.

Summary of Factors Affecting the Species

Section 4(a)(1) of the Endangered Species Act (16 U.S.C. 1531 *et seq.*) and regulations (50 CFR Part 424) promulgated to implement the listing provisions of the Act set forth the procedures for adding species to the Federal Lists. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1). These factors and their application to the Tooth Cave pseudoscorpion (*Microcreagris texana*), Tooth Cave spider (*Leptoneta myopica*), Bee Creek Cave harvestman (*Texella reddelli*), Tooth Cave ground beetle (*Rhadine persephone*), and Kretschmarr Cave mold beetle (*Texamaurops reddelli*) are as follows:

A. *The present or threatened destruction, modification, or curtailment of its habitat or range.* The primary threat to the five species comes from potential loss of habitat owing to ongoing development activities. Proximity of the caves inhabited by these species to the City of Austin makes them vulnerable to the continuing expansion of the Austin metropolitan area. Road, industrial, residential, and commercial developments that would adversely affect these species have already begun. Tooth, Amber, Kretschmarr, Kretschmarr Salamander, McDonald, and Root Caves are in an area for which a major residential, commercial, and industrial development has been proposed, and preliminary clearing and digging has begun. This area includes the entire known ranges of the Tooth Cave pseudoscorpion, the Tooth Cave spider, and the Tooth Cave ground beetle, all but one known locality of the Kretschmarr Cave mold beetle, and a large portion of the habitat of the Bee Creek Cave harvestman. Unless proper safeguards can be devised, this development could result in the filling in or collapsing of caves during road and building site preparation, and in alteration of drainage patterns that could affect the cave habitat. These species inhabit dry cave habitats that depend on some infiltration of groundwater. Disruption of this input would be harmful, as would excess input of water that would flood the caves. Flooding of habitat could also result from proposed no-discharge sewage effluent irrigation. Development of this area could also increase the flow of sediment, pesticides, fertilizers, and general urban runoff into the caves. Land alterations in this area were noted earlier (Reddell 1984), and have recently intensified. Landmarks have been altered so that it is difficult to relocate some caves, and large boulders have been placed in the entrance of Kretschmarr Cave on two occasions (Reddell 1984). This cave is an important habitat for the beetles included in this proposal. Development in this area is also likely to increase human visitation and vandalism in the caves, which are so small that even occasional episodes could adversely alter the cave habitat.

Tooth Cave is near one alternative route for a proposed water pipeline from Lake Travis. Even if it is bypassed by the direct path of the pipeline, operation of heavy construction equipment or blasting could adversely affect Tooth Cave and other caves in the area inhabited by these species.

Weldon Cave, which supports a population of the Bee Creek Cave harvestman, is in or very near the path of a recent road extension, and may no longer exist. Residential development is also occurring in this area, and is likely to be stimulated by the improved access provided by this road.

It is likely that most, if not all, of the five cave species occupied other caves that have already been lost to earlier development. This may have been the fate of Coffin Cave, which is historic habitat of the Tooth Cave mold beetle. Recent attempts to relocate this cave have not been successful.

B. *Overutilization for commercial, recreational, scientific, or educational purposes.* No threat from overutilization of these species is known to exist at this time. Collection for scientific or educational purposes could become a threat if localities become generally known.

C. *Disease or predation.* As the human population of the area around these caves increases, the problems of predation by and competition with exotic (non-native) species also increases. Human habitation introduces a complement of exotic invertebrate species into many areas, particularly in semiarid areas such as the plateaus northwest of Austin. These predatory species are transported into the area in various accompaniments of human occupation, including landscaping plants. Buildings, lawns, and shrubbery provide habitat from which these highly adaptable species can disperse. The relative accessibility of the shallow caves leaves them especially vulnerable to invasion by introduced invertebrate predators or competitors such as sowbugs, cockroaches, and fire ants.

D. *The inadequacy of existing regulatory mechanisms.* There are currently no laws that protect any of these species or that directly address

protection of their habitat. Cave protection laws of the City of Austin do not apply because these areas are all outside the city limits.

E. *Other natural or manmade factors affecting its continued existence.* These species are extremely vulnerable to losses because of their severely limited range and habitat and because of the naturally limited ability to colonize new habitats. These troglobitic species have little or no ability to move appreciable distances on the surface. The division of the limestone habitat into "islands" limits the mobility of the species through channels within the limestone. Moisture regimes, food supply, and other factors may also limit subsurface migrations and may account for the different distribution patterns seen among these five species.

The specific climatic factors within the caves, such as humidity, are affected by input through the cave entrance, the overlying soils, and the rocks in which the caves are formed. As discussed under factor A above, surface alterations can affect these conditions, as well as facilitate the flow of pollutants into the habitat.

The very small size of these habitats, in addition to the fragile nature of cave ecosystems in general, make these species vulnerable to even isolated acts of vandalism. As the human population of the area increases, the likelihood of such acts also increases.

The Service has carefully assessed the best scientific and commercial information available regarding the past, present, and future threats faced by these species in determining to make this rule final. Based on this evaluation, the preferred action is to list the Tooth Cave pseudoscorpion, the Tooth Cave spider, the Bee Creek Cave harvestman, the Tooth Cave ground beetle, and the Kretschmarr Cave mold beetle as endangered species. These species require the maximum possible protection provided by the Act because their extremely small, vulnerable, and limited habitats are within an area that can be expected to experience continued pressures from economic and population growth. Critical habitat has not been determined for reasons given in the next section.

Critical Habitat

Section 4(a)(3) of the Act, as amended, requires that, to the maximum extent prudent and determinable, the Secretary designate any habitat of a species which is considered to be critical habitat at the time the species is determined to be endangered or threatened. The Service finds that designation of critical habitat is not prudent for these species at this time. Their cave habitats are at the edge of an expanding urban area with a growing population. Increased human population density increases the likelihood of acts of vandalism that could irreversibly damage the caves. All involved parties and land owners will be notified of the location and importance of protecting these species' habitats. Protection of these habitats will be addressed through the recovery process and through the section 7 jeopardy standard. Therefore, it would not be prudent to determine critical habitat for these species at this time.

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Endangered Species Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, State, and private agencies, groups, and individuals. The Endangered Species Act provides for possible land acquisition and cooperation with the States and requires that recovery actions be carried out for all listed species. Such actions are initiated by the Service following listing. The protection required of Federal agencies and the prohibitions against taking and harm are discussed, in part, below.

Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any is being designated. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR Part 402. Section 7(a)(2) requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Service. No Federal involvement has been identified at this time. As development progresses, the Federal Department of Housing and Urban Development, the Federal Highway Administration, and the Environmental Protection Agency may become involved in funding or permitting projects. Any involvement by these agencies in development in the area of these caves would be a subject of consultation with the Service.

Section 9 of the Act and implementing regulations found at 50 CFR 17.21 set forth a series of general prohibitions and exceptions that apply to all endangered wildlife. These prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to take, import or export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any endangered fish and wildlife species. It also is illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Certain exceptions would apply to agents of the Service and State conservation agencies.

Permits may be issued to carry out otherwise prohibited activities involving endangered wildlife species under certain circumstances. Regulations governing permits are at 50 CFR 17.22 and 17.23. Such permits are available for scientific purposes, to enhance the propagation or survival of the species, and/or for incidental take in connection with otherwise lawful activities.

National Environmental Policy Act

The Fish and Wildlife Service has determined that an Environmental Assessment, as defined under the authority of the National Environmental Policy Act of 1969, need not be prepared in connection with regulations adopted pursuant to section 4(a) of the Endangered Species Act of 1973, as amended. A notice outlining the Service's reasons for this determination was published in the **Federal Register** on October 25, 1983 (48 FR 49244).

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Muchmore, W.B. 1969. New species and records of cavernicolous pseudoscorpions of the genus *Microcreagris* (Arachnida, Chelonethida, Neobisiidae, Ideobisiinae). American Museum Novitates No. 2932. 21 pp.

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Author

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List of Subjects in 50 CFR Part 17

Endangered and threatened wildlife, Fish, Marine mammals, Plants (agriculture).

Final Regulations Promulgation

Accordingly, Part 17, Subchapter B of Chapter I, Title 50 of the Code of Federal Regulations, is amended as set forth below:

PART 17—[AMENDED]

1. The authority citation for Part 17 continues to read as follows:

Authority: Pub. L. 93–205, 87 Stat. 884; Pub. L. 94–359, 90 Stat. 911; Pub. L. 95–632, 92 Stat. 3751; Pub. L. 96–159, 93 Stat. 1225; Pub. L. 97–304, 96 Stat. 1411 (16 U.S.C. 1531 *et seq.*); Pub. L. 99–625, 100 Stat. 3500 (1986), unless otherwise noted.

2. Amend § 17.11(h) by establishing a new taxonomic group, "Arachnids", with its entries, to follow the taxonomic group, "Insects", on the List of Endangered and Threatened Wildlife.

3. Section 17.11(h) is further amended by adding the following entries for Beetles, in alphabetical order under the taxonomic group heading, "Insects", to the List of Endangered and Threatened Wildlife.

§ 17.11 Endangered and threatened wildlife.

* * * * *

(h) * * *

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Insects							
*	*	*	*	*		*	
Beetle, Kretschmarr Cave mold	*Texamaurops reddelli*	U.S.A. (TX)	NA	E	327	NA	NA
*	*	*	*	*		*	
Beetle, Tooth Cave ground	*Rhadine persephone*	U.S.A. (TX)	NA	E	327	NA	NA
*	*	*	*	*		*	
Arachnids							
Harvestman, Bee Creek Cave	*Texella reddelli*	U.S.A. (TX)	NA	E	327	NA	NA
Pseudoscorpion, Tooth Cave	*Microcreagris texana*	U.S.A. (TX)	NA	E	327	NA	NA
Spider, Tooth Cave	*Leptoneta myopica*	U.S.A. (TX)	NA	E	327	NA	NA
*	*	*	*	*		*	

Dated: September 8, 1988.

Susan Recce,

Acting Assistant Secretary for Fish and Wildlife and Parks.

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